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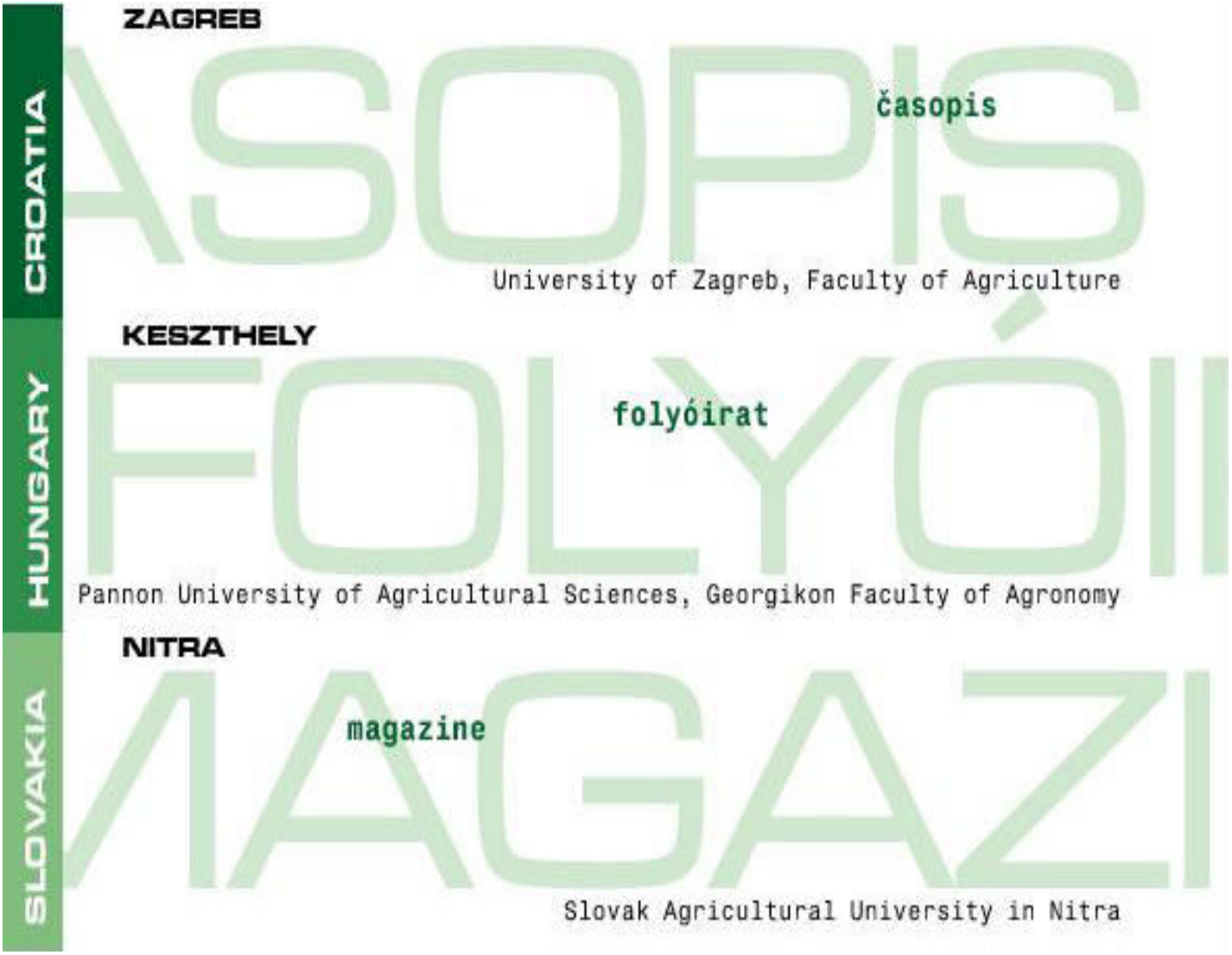

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Editorial

After all the hardships that usually accompany the creation of such a magazine, I am writing the editorial for the first issue with great expectations.

Social and economical changes of the central European countries in transition have brought major changes in agriculture, too. Instead of planned agriculture, the rules of the open market made demands for a very quick exchange of information and knowledge. Thus, the problems of countries in transition being similar, starting off the common journal seamed only natural.

At the beginning of the new millennium, advanced electronic technologies offer new, until recently unthinkable possibilities of disseminating information to the most remote places of the globe. To be able to share the knowledge in agriculture, the internationalization is necessary. At the same time every nation has the urge to cherish and preserve its national language. In an effort to reconcile these contrasting tendencies, we thought the common international electronic Journal on Central European Agriculture might provide an answer.

As seen from the first issue, Journal's Editorial Board is made up of three Croatian, three Hungarian and three Slovak members. The papers are published in English and/or in the language of the first author. If written in the language of the author, the mutual understanding is made sure of by bilingual description of tables and illustrations and detailed prolonged abstract in English.

The journal is intended for original scientific papers, short scientific communication and review papers on all aspects of sustainable agriculture. The scientists working on agricultural scientific and research programs in their middle and eastern European countries in transition are welcome to submit their research results to JCEA.

The Editor

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FEROMONI PČELA
HONEY BEE COLONY PHEROMONES

Maja DRAŽIĆ[1], Nikola KEZIĆ[2]

SAŽETAK

U suprotnosti s hormonima, koji se izlučuju unutar organizma i djeluju isključivo na organizam koj ih je proizveo, feromoni se izlučuju van organizma i djeluju na različite jedinke iste vrste.

Da bi bio efikasan, feromon mora biti usko specifičan tako da samo jedna životinjska vrsta reagira i vrlo djelotvoran tako da je potrebna vrlo mala količina da ne iscrpljuje organizam koji ga proizvodi.

Komunikacija feromonima je najvažnija za životinje koje žive u složenim društvima, kao što su npr. mravi, pčele ili kunići. Ova socijalna bića moraju komunicirati u sakupljanju hrane, održavanju zajednice i u obrani. Kroz odašiljanje kemijskih poruka, ove se životinje mogu nadopunjavati i organizirati prema statusu i ulozi svake jedinke.

Feromoni su jednako značajni za životinje koje žive pojedinačno, samo tada se kemijska komunikacija koristi rjeđe u specifičnim trenucima tijekom njihova života, npr. u vrijeme parenja.

Zbog ekonomske važnosti, a jednako i zbog zanimanja za organizaciju socijalnog života, feromoni pčela su među najčešće istraživanima.

Proizvodnja feromona u različitih jedinki u pčelinjoj zajednici ovisi o spolu i ulozi jedinke u zajednici, odnosno, o žlijezdama koje posjeduje jedinka. Trutovi neke žlijezde uopće nemaju, a neke su slabije razvijene nego u radilica ili u matice. Jednako tako, neke žljezde su u matice jako razvijene, a u radilica zakržljale i suprotno. Aktivnost pojedinih žlijezda vezana je za životnu dob, odnosno za poslove koje jedinka obavlja.

Utvrđeno je da feromone proizvode mandibularna (prednjočeljusna), Nasanovljeva, Koschewnikowa, tergitne, tarzalne (stopalne) i voštane žlijezde, jednako kao i rektum matice i membrana na bazi žalca radilica. Isto tako, značajan izvor feromona je i pčelinje leglo.

Istraživanja feromona imaju ekonomsko opravdanje jer se njihovom primjenom može manipulirati štetnim insektima na poljoprivrednim površinama, odnosno upravljati pčelama u vrijeme oprašivanja.

KLJUČNE RIJEČI: feromoni, pčelinje zajednice, komunikacija

ABSTRACT

Pheromones are chemicals produced as liquids by specialised cells or glands and transmitted into the environment as liquids or gases. In contrary to hormones, which are excreted in organism and have effect exclusively on organism that produced them, pheromones are excreted outside organism and effect on different individuals of the same species.

Pheromones mediate nearly all aspects of honeybee colony life including social defence, brood care, mating, orientation, foraging and reproduction.

Pheromone investigation has high economic importance. With use of pheromones it is possible to manipulate with pest insects on crops or to direct honeybees during pollination on target plants.

KEYWORDS: pheromones, honey bee colony, comunication

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HONEY BEE COLONY PHEROMONES

Maja DRAŽIĆ[1], Nikola KEZIĆ[2]

DETAILED ABSTRACT

Pheromones (greek *pherein* meaning “to transfer” and *hormon* meaning “to excite”) are chemicals produced as liquids by specialised cells or glands and transmitted into the environment as liquids or gases.

In contrary to hormones, which are excreted in organism and have effect exclusively on organism that produced them, pheromones are excreted outside organism and effect on different individuals of the same species.

To be efficient, a pheromone has to be highly specific to initiate response from only one species and very effective thus only small amount is sufficient.

Pheromonal communication is most important for animals living in social communities like ants, bees or rabbits. These social animals have to communicate during foraging, colony growth, and defence. Through chemical communication, these animals can cooperate and organise according to status and role of each individual in community.

Pheromones are important for solitary animals as well. Chemical communication is used in specific situations during life, for example, during mating period.

Pheromones mediate nearly all aspects of honeybee colony life including social defence, brood care, mating, orientation, foraging and reproduction.

Pheromone production in different individuals in honeybee colony depends not only on sex and role of each individual in community, however it depends on developed glands of the individual. Drones do not posses certain glands, and some glands are less developed when comparing workers and queens. At the same time, queens have some glands highly developed that are reduced at workers and contrary. Activity of certain glands is related to the age or occupation of an individual.

Pheromones are produced in mandibular, Nasanow, Koschewnikow, tergit and vax glands, as well as rectum of a queen and membrane on the sting basis. At the same time, important source of pheromones is honeybee brood.

Pheromone investigation has high economic importance. With use of pheromones it is possible to manipulate with pest insects on crops or to direct honeybees during pollination on target plants.

KEYWORDS: pheromones, honey bee colony, comunication

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UVOD

U mjerilima cijelog životinjskog svijeta, vizualne i zvučne signale za sporazumijevanje koristi mali broj životinjskih vrsta, dok su kemijske poruke karakteristika većine organizama. Ovo je naročito izraženo kod insekata, na kojima je stečeno najviše znanja o kemijskoj komunikaciji.

Većina specifičnih reakcija insekata, kao što su seksualno privlačenje, raspršivanje, agregacija, agresivnost, signaliziranje opasnosti, regulirane su kemijskim tvarima.

U suprotnosti s hormonima, koji se izlučuju unutar organizma i djeluju isključivo na organizam koj ih je proizveo, ove se kemijske komponente izlučuju van organizma i djeluju na različite jedinke iste vrste. Ovi se spojevi zovu feromoni, riječ izvedena iz grčke riječi *pherein* što znači prenošenje i *hormon* što znači pobuđivanje. Sve tvari koje su proizvedene u sekretornim žljezdama nazivaju se semiospojevi.

Kemijskim signalima je moguće prenositi i neke poruke između različitih životinjskih vrsta, a takve spojeve nazivamo alomonima.

Općenito o feromonima

Feromoni su spojevi koje izlučuju životinje, a izazivaju fiziološke ili ponašajne odgovore druge životinje iste vrste, odnosno, djeluju kao kemijska poruka. Ovakav model komunikacije se sastoji iz tri dijela:

- mehanizma koji emitira poruku, obično u formi žljezdanog organa koji je specijalizirane strukture za oslobađanje feromona
- medija kroz koji se kemijska poruka odašilja, obično je to zrak, voda ili direktni kontakt.
- mehanizma za primanje kemijske poruke, a to je mirisni ili okusni organ organizma koji sadrži specifične stanice – kemoreceptore.

Udaljenost na koju feromon putuje da prenese kemijsku poruku ovisi o:

- učestalosti pri kojoj emiter oslobađa feromon
- najmanjoj koncentraciji molekula feromona koje primalac signala može detektirati
- odlikama medija u kojem su molekule otopljene na minimalnu detektabilnu koncentraciju
- udaljenosti na koju je potrebno prenijeti poruku

Feromone je teško klasificirati iz više razloga. Gotovo sve životinje od primitivnih protozoa do viših primata koriste feromone kao sredstvo za komunikaciju. Feromoni se razlikuju kemijski od vrste do vrste i značajno se razlikuju u bliskih organizama.

Postoje neke sličnosti u reakcijama koje izazivaju, pa se utjecaj feromona može klasificirati s obzirom na reakciju primaoca signala, koja može biti u jednoj od dvije forme:

Feromon može proizvesti trenutni efekt "*releaser effect*", gotovo trenutnu promjenu u ponašanju recipijenta. Na primjer, članovi životinjske vrste mogu pobjeći iz nekog prostora kao odgovor na alarmne feromone izlučene od jednog člana zajednice,

Feromon može proizvdesti dugotrajni "*primer effect*". U ovom slučaju odgovor primaoca nije direktna reakcija u ponašanju, nego lanac fizioloških promjena. Primjer je feromon kojeg izlučuje pčelinje leglo, a koji sprečava razvoj jajnika u pčela radilica.

Zbog velike raznolikosti feromona, teško je opisati opće odlike, bilo fizikalne ili kemijske. Potpuno različite vrste molekula prenose slične poruke u različitih organizama.

Da bi bio efikasan, feromon mora biti usko specifičan tako da samo jedna životinjska vrsta reagira i vrlo djelotvoran tako da je potrebna samo mala količina da ne iscrpljuje organizam koji ga proizvodi.

Većina poznatih feromona sadrži zmeđu 5 i 17 ugljikovih atoma. Ovaj raspon dozvoljava dovoljno kombinacija i struktura molekula da kreira feromon koji je jedinstven za danu vrstu. Ovi prirodni produkti, velike raznolikosti uključuju organske kiseline, ketone, alkohole i velik broj alifatskih i aromatskih estera [3].

Hlapivost je važna fizikalna odlika feromona koji koriste zrak kao medij za transport. Hlapiva komponenta je ona koja isparava na relativno niskoj temperaturi. Visoka hlapivost dozvoljava feromonima da budu trenutno transportirani kroz zrak.

U velikom dijelu, hlapivost tvari ovisi o njezinoj molekularnoj masi tako da se povećanjem molekule smanjuje hlapivost. Feromoni sa 5 do 17 ugljikovih atoma su dovoljno maleni da se smatraju visoko hlapivim i da jednostavno putuju zrakom.

Feromoni koji se prenose vodom moraju biti stabilni i relativno netopivi u tom mediju. Feromoni koji daju signal u vrlo kratkom vremenu moraju se brzo razgraditi.

Identifikacija feromona

Identifikacija feromona vrlo je zahtijevan proces, a započinje prikupljanjem i izdvajanjem sekreta žljezda. U prikupljenom se uzorku zatim odjeljuju različiti spojevi, te se određuje kemijski sastav i građa svake pojedine komponente.

Nakon što je pojedini kemijski spoj izoliran, koriste se različite tehnike za identifikaciju, na primjer, kemijske reakcije, fizikalna mjerenja, te metode kojima se utvrđuje biološka reakcija organizma na spoj. Biološke metode se moraju provoditi u uvjetima što sličnijim prirodnim, a u obzir se moraju uzeti i fiziloško stanje i prethodno iskustvo testnih jedinki. Uvijek je jednostavnije ispitivanje tvari koje izazivaju trenutnu reakciju (*release*) nego tvari koje izazivaju dugotrajne promjene (*primer*) u organizmu [10].

Često je teško primjeniti biološke metode ispitivanja feromona, tako da iznova pokušavaju pronaći jednostavnije načine za ove pokuse [24].

Razvojem i primarnim korištenjem drugih osjetila, životinje i dalje zadržavaju komunikaciju feromonima.

Komunikacija feromonima je najvažnija za životinje koje žive u složenim društvima, kao što su npr. mravi, pčele ili kunići. Ova socijalna bića moraju komunicirati u sakupljanju hrane, održavanju zajednice i u obrani. Kroz odašiljanje kemijskih poruka, ove se životinje mogu nadopunjavati i/ili organizirati prema statusu i ulozi svake jedinke.

Feromoni su jednako značajni za životinje koje žive pojedinačno, samo tada se kemijska komunikacija koristi rjeđe u specifičnim trenucima tijekom njihova života, npr. u vrijeme parenja.

TIPOVI FEROMONA

Najčešći način klasificiranja feromona je prema tipu poruke koju feromon primarno prenosi. Tako feromone možemo klasificirati kao:

- seksualne atraktante
- alarmne feromone
- feromone za agregaciju jedinki
- feromone za disperziju jedinki

Seksualni atraktanti

Seksualne feromone izlučuju životinje jednog spola, a izazivaju promjene u ponašanju kod drugog spola. Ove promjene osiguravaju oplodnju i time širenje vrste. Jednom emitiran, seksualni feromon može privući potencijalnog partnera na većoj udaljenosti. Primalac prati povećanje koncentracije feromona koja ovisi o udaljenoti i kreće se od nižih prema višim koncentracijama.

Alarmni feromoni

Ovi feromoni djeluju na jedinku tako da trenutno napusti područje ili aktiviraju obrambeni mehanizam, ovisno o vrsti.

Zanimljiv je način funkcioniranja alarmnih feromona kod mrava. Kad je feromon prvi put otpušten u zrak, hlapivi materijal formira oblak oblika kugle, koji doseže radijus od 6 cm u 13 sekundi. Tad se oblak počinje smanjivati sve dok signal ne zamre. Vanjski rub oblaka sadrži nisku koncentraciju alarmne tvari, koja služi da na mjesto alarma privuče ostale članove zajednice. Na taj način mravi odgovaraju na zahtjev o pomoći. Središnji dio oblaka sadrži dovoljnu koncentraciju alarmnog feromona da pobudi i zadrži karakterističnu uzbuđenje.

Agregacijski feromoni

Ovi feromoni služe da dovedu članove zajednice u jedinstvenu grupu. Agregacija se može definirati kao lokaliziranje više jedinki u blizinu izvora feromona. Agregacijski feromoni služe da ostale članove zajednice dovedu do izvora hrane ili do mjesta pogodnog za naseljavanje.

Disperzijski feromoni

Vjeruje se da disperzijski hormoni mogu služiti za više bioloških funkcija

- mogu održavati optimalnu raspršenost između pojedinih životinja,
- mogu održavati optimalnu odvojenost između teritorija socijalnih skupina životinja iste vrste i
- mogu uzrokovati raspršivanje članova vrste kad se pojavi opasnost

Teritorij je područje okupirano od jedne ili više životinja koje prepoznaju područje kao njihovo isključivo vlasništvo i brane ga od jedinki iste vrste.

Feromoni se koriste da se oglasi ostalim članovima vrste da je teritorij zaposjednut. Životinje ostavljaju sekrete u kojima su otopljeni feromoni tako da znak ostaje i ako je životinja odsutna.

Ponovno, može se govoriti o preklapanju potkategorija feromona, npr. alarmni feromoni se u nekim slučajevima mogu smatrati feromonima za disperziju, odnosno za agregaciju jedinki – ovisno kako pojedine vrste reagiraju na signal o opasnosti.

FEROMONI PČELA

Zbog ekonomske važnosti, a jednako i zbog zanimanja za organizaciju socijalnog života, feromoni pčela su među najčešće istraživanima.

Najčešće su istraživane medonosne pčele (Apis mellifera) porijeklom iz Europe, Afrike i Zapadne Azije, koje su kasnije proširene u Sjevernu i Južnu Ameriku, Australiju i Centralnu i Istočnu Aziju. Daleko manje istraživanja je provedeno na autohtonim azijskim vrstama medonosne pčele (Apis dorsata, Apis florea i Apis cerana).

Nema puno podataka o zaprekama u komunikaciji feromonima između različitih pčelinjih zajednica, premda sekret mandibularne žlijezde matica u različitih pasmina može imati donekle različite omjere istih komponenti [10].

Žlijezde koje proizvode feromone

Proizvodnja feromona u različitih jedinki u pčelinjoj zajednici ovisi o spolu i ulozi jedinke u zajednici, odnosno, o žlijezdama koje posjeduje jedinka. Trutovi neke žlijezde uopće nemaju, a neke su slabije razvijene nego u radilica ili u matice. Jednako tako, neke žljezde su u matice jako razvijene, a u radilica zakržljale i suprotno. Aktivnost pojedinih žlijezda vezana je za životnu dob, odnosno za poslove koje jedinka obavlja.

Utvrđeno je da feromone proizvode mandibularna (prednjočeljusna), Nasanovljeva, Koschewnikowa, tergitne, tarzalne (stopalne) i voštane žlijezde, jednako kao i rektum matice i membrana na bazi žalca radilica. Isto tako, značajan izvor feromona je i pčelinje leglo.

Mandibularna (prednjočeljusna) žlijezda leži na bazi prednjih čeljusti. Dobro je razvijena i kod radilica i kod matice, a kod

matica je naročito velika. Osim što djeluje kao feromon, sekret ove žlijezde se koristi za čitav niz funkcija, a prema Tomašecu [25] otapa vosak, propolis i kožicu peludnih zrnaca, odnosno kokon.

Tergitne žlijezde su smještene od četvrtog do šestog abdominalnog tergita. Vrlo su dobro razvijene u mladih matica, a radilice ih nemaju. Jedina uloga im je proizvodnja feromona.

Voštane žlijezde posjeduju radilice, a nalaze se od četvrtog do sedmog trbušnog segmenta kao parne tvorbe. Voštane žlijezde su najbolje razvijene kod mladih pčela u dobi od 10 do 18 dana, ali prema potrebi pčele mogu izlučivati vosak i u kasnijoj dobi [25]. Utvrđeno je da ljuščice voska i mlada voština sadrže tvari koje djeluju kao feromoni [2; 3; 4, 10].

Nasanovljeva žlijezda, katkad opisivana kao mirisna jer proizvodi jak i karakterističan miris, nije razvijena u matice nego jedino u radilica. Ova se žlijezda nalazi na dorzalnoj površini sedmog abdominalnog tergita, a njezin sekret se nakuplja u mirisnom kanalu koji je normalno pokriven [23]. Kad pčela počne izlučivati miris, posebnim mišićima povuče zadnji kolutić prema dolje, pokrovni tergit prema gore, a sama žlijezda se izboči van [25]. Nasanovljeva žlijezda proizvodi višefunkcionalne feromone.

Koschewnikowa žlijezda je sastavljena od malih nakupina stanica u komori žalca. Ovaj organ nije tako dobro razvijen u radilica kao u matica, a za svaku od kasti ima drugačiju funkciju.

Opna žalčanog aparata je izvor važnog feromona koji se oslobađa kad je žalac ispružen. Za membranu na bazi žalca, za koju se dugo smatralo da luči feromone, su Cassier i sur. [7] dokazali da samo služi kao rezervoar za feromone iz Koschewnikowe žlijezde i za feromone iz opne žalca, što su 1995. potvrdili Lensky i sur [13].

Žlijezde na tarzusu – stopalu i matice i radilica su dobro razvijene, a njihova uloga se u zajednici bitno razlikuje.

Nedugo je otkriveno da rektum matice, ali ne i radilica, izlučuje važan feromon. Žljezdani izvor ovog feromona nije otkriven, pa se navodi da je izvor feromona rektum jer se feromon izlučuje u rektalnom eksudatu.

ODLIKE FEROMONA IZ POJEDINIH ŽLIJEZDA PČELA

Feromoni mandibularne žlijezde

Spojevi proizvedeni u mandibularnoj žlijezdi matica su centralni u svim aktivnostima zajednice. Njihove različite uloge uključuju atraktivnost za parenje, inhibiciju uzgoja matičnjaka, okupljanje radilica za vrijeme rojenja i zadržavanje radilica u blizini legla. Ovo posljednje omogućeno je stalnim boravkom pratilja oko matice koje maticu dodiruju ticalima, prednjim nogama ili ustima. Za vrijeme socijalne izmjene hrane (trophallaxis) radilice međusobno prenose i matične feromone [9, 16; 17].

Prvi identificirani spoj u matičnom feromomu bio je 9-keto-2-dekaenoična kisleina (9-ODA). Kasnije je identificirana 9-hidroksi-2-dekaenoična kiselina (9-HDA). Smjesa ovih spojeva sprečava uzgoj matičnjaka u zajednici. Uz ove spojeve u sekretu mandibularne žlijezde matice identificirani su p-hidroksibenzoat i 4-hidroksi-3-metoksifeniletanol [4, 10, 27, 29;] koji pojačavaju djelovanje matičnog feromona. U sekretu manadibularne žlijezde matice identificiran je još niz spojeva koji biološkim metodama testiranja nisu pokazali feromonalnu aktivnost [10].

Sekret mandibularne žlijezde ima važnu ulogu u pokretanju, koheziji i stabilnosti roja, a jednako tako je vrlo jak seksualni atraktant, koji redovito privlači trutove neoplođenoj matici [14, 28, 30]. Neoplođene matice proizvode maksimalnu količina 9-ODA u proljeće, u vrijeme učestalih sparivanja i učestale pojave rojeva [4].

Kad kućne pčele postaju čuvarice ili sakupljačice, u mandibularnoj žlijezdi počinu proizvoditi vrlo mirisnu tvar 2-heptanon (2-HP). 2-HP ima ulogu slabog alarmnog feromona na ulazu u košnicu, ali je njegova učinkovitost 20-70 puta slabija nego alarmnih feromona iz žalčanog aparata [4, 8, 10]. Jedna od vjerojatnih funkcija je da se feromon koristi direktno u obrani jer djeluje iritirajuće kad se nanese na tijelo pčele ili drugih insekata, pa tako ima ulogu obrambenog alomona. Primjećeno je da pčele prilikom obrane grizu uljeza, te Free [10] smatra, ne samo da se pčele na taj način brane nego da obilježavaju uljeza koji postaje prepoznatljiv ostalim pčelama.

Dodatno, velika koncentracija 2-HP djeluje kao repelent i čini se da je to jedna od komponenti kojima sakupljačice obilježavaju cvjetove koji ne mede, dok suprotno, u malim koncentracijama 2-HP djeluje kao atraktant.

Feromoni Nasanovljeve žlijezde

Radilice šire feromon tako da izlože žlijezdu, a samu disperziju pojačavaju lepezanjem krila [23]. Glavne mirisne komponente su monoterpeni, među kojima je najzastupljeniji alkohol geraniol – jedan od sastojaka ružinog ulja. Geraniol pčele proizvode u dobi kad prestaju biti kućne, a najviše ga proizvode sabiračice. Još dva alkohola ulaze u sastav sekreta nasanovljeve žlijezde, od kojih je nerol zastupljen u malim količinama, a farnezola ima upola manje nego geraniola. Uz ove terpenoide u sekertu Nasanovljeve žlijezde izoliran je čitav niz drugih alkohola, aldehida i njihovih derivata, te topivi proteini koji zajedno pridonose ukupnoj funkciji mirisa [6].

Sekret Nasanovljeve žlijezde služi kao signal za orijentaciju, koji može vrlo brzo privući sabiračice na izvor hrane. Isto tako, sabiračice koje su imale problema u orijentaciji pri povratku u košnicu zastaju na letu, izlože žlijezdu i šire feromon [4, 10, 23].

Pčele često izlažu Nasanovljevu žlijezdu prilikom sakupljanja hrane (na cvijetu) ili vode, ali bez lepezanja krilima, tako da širenje feromona nije usmjereno. Na taj način pomažu ostalim sakupljačicama u orijentaciji i pronalaženju izvora hrane [10].

Druga uloga sekreta Nasanovljeve žlijezde je u procesu rojenja kad ima ulogu okupljanja roja, zajedno s matičnim feromonom. Ako pri rojenju pčele izgube kontakt s maticom, prve koje je pronađu počinju lučiti feromon, te se roj vrlo brzo okupi oko matice [23].

Schmidt i sur. [22] su korištenjem sintetskih feromona ustanovili da je za održavanje roja bitnija prisutnost Nasanovljevog nego matičnog feromona. Kad odvode roj na novu lokaciju pčele izviđačice ispuštaju Nasanovljev feromon i privlače roj u novu nastambu [21].

Feromoni Koschewnikove žlijezde

Koschevnikova žlijezda oplođene matice proizvodi feromone koji su izrazito privlačni radilicama. Nije potvrđeno da ovaj feromon sprečava razvoj jajnika u radilica [10]. U oplođene matice žlijezda degnenerira u dobi od godine dana [4].

Koschewnikove žlijede u radilica su izvor jakih alarmnih feromona, koji se oslobađaju kad je žalac ispružen. Alarmni feromon se nakuplja u naboranoj membrani na bazi žalca i nastavlja funkcionirati kad je žalac otrgnut iz tijela radilice i ostao u tijelu žrtve. Ovo rezultira da pčele nastave napadati mjesto prethodnog uboda. Izopentilacetat (IPA) je bila prva identificirana komponenta kao dio žalčanog feromona. IPA ima 20-70 puta jače djelovanje kao alarmni feromon nego 2-HP - produkt mandibularne žlijezde radilica. Sadržaj IPA je maksimalan u dobi kad radilice postanu sabiračice ili stražarice. Nije utvrđeno da matice proizvode IPA. Uz izopentilacetat, u žalčanom feromonu identificiran je niz estera i alkohola i nešto kiselina. Raznolikost komponenti proizvedenih da služe kao alarmni feromon je iz razloga što takva smjesa tvari osigurava duže trajanje signala [4, 12].

Feromoni opne (ljuskice) žalčanog aparata

Utvrđeno je da opna žalca izlučuje feromone koji dopunjuju djelovanje feromona Koschevnikovih žlijezda i osnovna im je namjena alarmiranje. Nije otkrivena žlijezda koja proizvodi feromone, ali je utvrđeno da opna žalčanog aparata ima strukturu primitivne žlijezde [7].

Feromoni tergitnih žlijezda

Abdominalne tergitne žlijezde matica proizvode feromone koji služe radilicama kao sredstvo za prepoznavanje matica, koji inhibiraju gradnju matičnjaka i razvoj jajnika u radilica. Ovi feromoni se, za razliku od mandibularnih, prenose direktnim kontaktom radilica s maticom. Sekret tergitnih žlijezda u interakciji je sa sekretom mandibularnih žlijezda privlači trutove i inducira parenje. Trutovi mogu detektirati mandibularne feromone matice na udaljenosti preko 50 metara, a feromoni tergitnih žlijezda dominiraju na udaljenosti do 30 centimetara [4, 10; 31].

Feromoni tarzalnih žlijezda (Footprint pheromon)

Matica ostavlja uljasti sekret tarzalnih žlijezda po površini saća pomoću jastučića na stopalu. Ovaj feromon zajedno s feromonima mandibularne žlijezde, kad je prisutan na saću, sprečava gradnju matičnjaka i u prenapučenim košnicama. Za potpunu inhibiciju gradnje matičnjaka potrebna je prisutnost oba feromona, jer niti jedan samostalno nije dovoljno učinkovit [10].

Tarzalne žlijezde radilica proizvode feromone, koje ostavljaju na ulazu u košnicu. Privlačnost feromona raste s porastom broja radilica koje ga ostavljaju. Radilice markiraju izvore hrane ovim feromonima i tako povećavaju privlačnost za ostale sabiračice [4].

Feromoni rectuma matica koji odbijaju radilice

Prirodna proizvodnja matica u pčelinjoj zajednici rezultira razvojem nekoliko neoplođenih matica, od kojih će samo jedna ostati matica u matičnoj zajenici. Kao posljedica toga što se matica pari s više trutova, u pčelinjoj zajenici uobičajeno ima nekoliko subfamilija od kojih sve imaju istu majku, a svaka potfamilija ima istog oca. Smatra se da pčele mogu prepoznati i među radilicama i među neoplođenim maticama prave sestre, odnosno polusestre, pa često dolazi do sukoba između potporodica. Poznat je sukob između matice i matice, ali je utvrđeno da se u zajednici mogu sukobiti matice i radilice, što je jače izraženo ako potiču od različitih potporodica [5, 19].

Neoplođene matice su često izložene agresivniosti radilica koje ih napadaju bez vidljivog povoda [2, 3, 19]

Neoplođene matice su razvile specifičan način obrne. Prilikom sukoba s radilicama, ove matice izlučuju veliku količinu vrlo mirisnog analnog sekreta (fecesa ili exudata) koji vrlo očito smanjuje i smiruje agresivnost radilica te istovremeno uzrokuje čišćene vlastitog tijela [2, 3, 5, 19, 20].

Utvrđeno je da je glavni sastojak ekskreta, odgovoran za ovakvo ponašanje *o*-aminoacetofenon (*o*-AAP). Za vrijeme prva 24 sata života nakon izlaska iz matičnjaka matica je rijetko napadnuta, pa se u tom razdoblju u fecesu ne može utvrditi *o*-AAP. Radilice prestaju napadati maticu nakon što je matica oplođena i u dobi od oko 14 dana, te ona prestaje proizvoditi ovu komponentu.

Feromoni legla

Sposobnost socijalnih insekata da identificiraju leglo i još preciznije spol i razvojni stadij je neophodna za jedinke koje brinu o leglu.

Kemijski signal, mješavina oko 10 različitih masnih kiselina i estera utvrđena na kutikuli ličinki ima dugotrajno (primer effect) djelovanje na radilice. Mohammedi i sur. [15] su utvrdili da ovaj feromon legla stimulira razvoj ždrijelnih žlijezda pčela hraniteljica, dok su Arnold i sur. [1] utvrdili da feromon legla kod radilica inhibira razvoj jajnika i polaganje jaja. No, jednako tako, kemijske signale koje proizvodi pčelinje leglo je u stanju detektirati grinja *Varroa jacobsoni*, koja time izaziva značajne štete u pčelinjim zajednicama [11; 26].

Feromoni trutova

Veličina trutovskog legla i broj trutova u zajednici u pozitivnoj je korelaciji s brojem radilica. Smatra se da matični

feromon regulira gradnju trutovskog saća, pa u malim zajednicama nema trutova za razliku od velikih zajednica [10], odnosno da trutovsko leglo proizvodi inhibirajuće feromone koji sprečavaju daljnje zalijeganje trutovskog legla kad populacija dosegne određeni broj trutova [18].

No, sami trutovi u manidbularnim žlijezdama proizvode feromone koji uvjetuju okupljanje trutova na mjestima koja su pogodna za parenje [4].

Feromoni voska

U vosku iz kojeg je izgrađeno saće moguće je utvrditi čitav niz različitih spojeva. Za dio hlapivih spojeva voska se smatra da potječu od biljaka s kojih pčele sakupljaju hranu. Analiza voska kojeg su proizvele pčele hranjene samo šećernim sirupom bez mogućnosti izlaska na pašu ukazao je da same pčele mogu sintetizirati dio ovih spojeva. Uloga ovih hlapivih tvari je da stimuliraju i pojačaju nagon za prikupljanje hrane u radilica [3].

UMJESTO ZAKLJUČKA

Istraživanja feromona su naglašena u posljednje vrijeme, a potaknuta su njihovom mogućom primjenom bilo kao atraktanata ili kao repelentata na poljoprivrednim površinama, jer je upotreba feromona u kontroli štetnih insekata jedan od načina da se smanji primjena insekticida.

Prednost je feromona da ne mogu izazvati rezistenciju i nisu opasni za druge životinjske vrste.

Istraživanja feromona unutar pčelinje zajednice nam omogućuje da razumijemo različite oblike ponašanja. No, ne smijemo zaboraviti da med nije najvažniji pčelinji proizvod nego je to oprašivanje kultiviranog i samoniklog bilja [31]. Sintetski feromoni imaju komercijalnu primjenu u privlačenju pčela na određene poljoprivredne kulture radi oprašivanja, čime značajno povećavaju atraktivnost biljke za pčele.

LITERATURA

[1] Arnold, G., Le Conte, Y., Trouiller J., Hervet, H., Chappe B., Masson C. (1994) Inhibition of Worker Honeybee Ovaries Development by a Mixture of Fatty Acid Esters From Larvae. Comptes Rendus de l Academie des Sciences Serie III – Sciences de la Vie – Life Sciences. 317 (6) 511-515.

[2] Blum, M. S., Fales, H. M. (1988): Eclectic Chemiossociality of the Honeybee: A Wealth of Behaviors, Pheromones and Exocrine Glands. Journal of Chemical Ecology, 14 (11) 2099-2107

[3] Blum, M. S. (1989) The Chemistry and Roles of Eusocial Insect Pheromones and Allomones. Phytochemical Ecology: Allelochemicals, Mycotoxins and Insect Pheromones and Allomones. C. H. Chou; G. R. Waller, Eds. Institue of Botany, Academia Sinica Monograph Series No. 9. Taipei, ROC 39-47.

[4] Blum, M. S. (1993) Honey Bee Pheromones. In: The Hive and Honeybee. (Graham, J.M. ed.) Dadant and Sons, Hamilton, Ilinois, 373 – 400.

[5] Breed, M.D., Stiller, T. M., Blum, M.S., Page, R.E. (1992) Honeybee Nestimate Recognition: Effects of Queen Fecal Pheromones. Journal of Chemical Ecology. 18 (9) 1633-1640

[6] Cassier, P., Lensky, J. (1994) The Nasanov Gland of the Workers of the Honeybee (Apis mellifera L): Ultrastructure and Behavioural Function of the Terpenoid and Protein Components. J. Insect Physiol. 40: 577-584

[7] Cassier, P., Tel-Zur, D., Lensky, Y. (1994) The Sting Sheaths of Honey Bee Workers (Apis mellifera L.): Structure and Alarm Pheromone Secretion. J. Insect Physiol. 40: 23-32

[8] Collins, A. M., Rinderer, T.E., Daly, H.V., Harbo, J.R., Pesante D. (1989) Alarm Pheromone Production by Two Honeybee (Apis mellifera) Types. Journal of Chemical Ecology, Vol. 15, No 6: 1747 – 1756.

[9] Crailsheim K. (1998) Trophallactic Interactions in the Adult Honebee (Apis mellifera L.). Apidologie 29: 97-112

[10] Free, J. B. (1987) Pheromones of Social Bees. Chapman and Hall. London

[11] Le Conte, Y., Arnold, G., Trouiller, J., Masson, C., Chappe, B. (1990) Identification of a Brood Pheromone in Honeybees. Naturwissenschaften 77, 334-336.

[12] Lensky, Y., Cassier, P., Rosa, S., Grandperrin D. (1991) Induction of Balling in Worker Honeybees (Apis mellifera L.) by "Stress" Pheromone from Koschewnikow Glands of Queen Bees: Behavioural, Structural and Chemical Study. Comp. Biochem. Physiol 100 (3): 585-594

[13] Lensky, Y., Cassier, P., Telzur, D. (1995) The Setaceouss Membrane of Honey Bee (Apis mellifera L) Workers Sting Aparatus – Structure and Alarm Pheromone Distribution. Journal of Insect Physiology 41 (7) 589-595

[14] Loper, G. M., Wolf, W. W., Taylor, O. R. (1993) Radar Detection of Drones Responding to Honeybee Queen Pheromone. J. of Chemical Ecology 19 (9) 1929-1938

[15] Mohhamedi A., Crauser. D., Paris A Leconte, Y. (1996) Effect of a Brood Pheromone on Honeybee Hypopharingeal Glands. Comptes Rendus de l Academie des Sciences Serie III – Sciences de la Vie – Life Sciences. 319 (9) 769 – 772.

[16] Nauman, K. (1991) Grooming behaviors and the ranslocation of queen mandibular gland pheromone on worker bees (Apis mellifera L). Apidologie 22: 523-531

[17] Nauman, K., Winston, M.L., Slessor, K.N., Prestwich, G.D., Webster, F. X (1991). Production and transmission of honey bee queen (Apis mellifera L.) mandibular gland pheromone. Behav. Ecol. Sociobiol 29: 321-332

[18] Omholt, S. W. (1988) Drone Production in Honeybee Colonies: Conrolled by a Longlasting Inhibitory Pheromone from the Drones, J. theor Biol 134, 309-318

[19] Page, R. E., Post, D. C., Blum, M.S. (1987) A Honey Bee Pheromone that Repels Workers. Chemical Signals. In: Chemistry and Biology of Social Insects (ur. Eder i Rembold) Verlag J. Peperny, Munchen

[20] Page, R. E., Blum, M. S., Fales, H. M. (1988) o-Aminoacetophenone, a pheromone that repels honeybees (Apis mellifera L.). Experientia 44: 270-271

[21] Schmidt, J. O. (1994) Attraction of Reproductive Honey Bee Swarms to Artificial Nests by Nasanov Pheromone. J. of Chemical Ecology 20 (5) 1053-1056.

[22] Schmidt, J. O., Slessor, K.N., Winston, M.L. (1993) Roles of Nasanov and Queen Pheromones in Attraction of Honeybee Swarms. Naturwissenschaften 80: 573-575

[23] Snodgras, R. E. (1910) The Anatomy of the Honeybee. Dept. of Agriculture, Washington, DC

[24] Telzur, D., Lensky Y (1995): Bioassay And Apparatus For Measuing The Stinging Response Of An Isolated Worker Honey-Bee (Apis mellifera L var. ligustica Spin). Comparative Biochemistry & Physiology A-Comparative Physiology. 110 (4) 281-288

[25] Tomašec, I. Biologija pčela. Nakladni zavod Hrvatske, Zagreb, 1949. pp 94

[26] Trouiller, J., Arnold, G., Le Conte, Y., Masson, C., Chappe, B. (1991) Temporal Pheromonal and Kariomonal Secretion in the Brood of Honeybees. Naturwissenschaften 78, 368-370.

[27] Willis, L.G., Winston, M.L., Slessor K. N. (1990) Queen Honey Bee Mandibular Pheromone Does not Affect Worker Ovary Development. Can. Ent. 122: 1093-1099

[28] Winston, M. L., Slessor, K.N., Willis, L.G., Naumann, K., Higo, H.A., Wyborn, M.H., Kaminski L. A. (1989) The Influence of Queen Mandibular Pheromones on Worker Attraction to Swarm Clusters and Inhibition of Queen Rearing in the Honey Bee (Apis mellifera L.). Insectes Sociaux, Paris, 36: 15-27

[29] Winston, M. L., Higo, H.A., Slessor, K.N. (1990) Effect of Various Dosages of Queen Mandibular Gland Pheromone on the Inhibiton of Queen Rearing in the Honey Bee (Hymenoptera: Apidae). Annals of the Entomological Society of America, 83 (2): 234-238

[30] Winston, M. L., Higo, H. A., Colley, S.J., Pankiw, T. Slessor, K.N. (1991) The Tole of Queen Mandibular Pheromone and Colony Congestion in Honey Bee (Apis mellifera L.) Reproductive Swarming (Hymenoptera: Apidae) Journal of Insect Behavior, Vol. 4, No. 5: 649-660.

[31] Winston, M. L., Slessor, K. N. (1992) The Essence of Royalty: Honey Bee Queen Pheromone. American Scientist, 80: 374-385

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ANALIZA MALIH OBITELJSKIH KOMERCIJALNIH RIBNJAKA U HRVATSKOJ

THE ANALYSIS OF SMALL FAMILY COMMERCIAL FISH FARMS IN CROATIA

Tomislav TREER, Roman SAFNER, Ivica ANIČIĆ

SAŽETAK

Značajne ekonomske i političke promjene koje su se u proteklom desetljeću dogodile u Hrvatskoj utjecale su i na male obiteljske farme da se mnoge među njima priklone i ribarstvu. Većina ih je započela ovaj posao bez ikakvog znanja i iskustva. Zbog toga smo intervjuirali 13 farmera s ciljem da prikupimo podatke o njihovim farmama, obiteljima i problemima s kojima se suočavaju. Prosječna farma posjeduje oko 1 ha vodene površine, ima 4 člana obitelji, a prihod povezan s ribarstvom sudjeluje s oko 70% u ukupnom prihodu. Vlasnik je obrtnik četrdesetih godina, koji prodaje oko 3 tone ribe godišnje prvenstveno kroz restoran i sportski ribolov, obzirom da se u današnjoj situaciji najteže zarađuje samo uzgojem riba. Pri izgradnji ribnjaka, pored pravila ribarske znanosti treba poštivati i ona uređenja krajobraza. Također je farmerima potrebno ponuditi bolje kreditne uvjete kako bi lakše započeli svojim poslom, kao i reducirati mnogobrojne naknade koje prate izgradnju ribnjaka i proizvodnju. Hrvatska poljoprivredna savjetodavna služba trebala bi se organizirati i u kvalitetnom praćenju ovakvih farmi.

KLJUČNE RIJEČI: **obitelj, ribnjak, Hrvatska, sportski ribolov**

ABSTRACT

The significant economical and political changes that affected Croatia in last decade influenced the approach of small family farmers to fisheries as well. Most of them started that job without any knowledge and experience. That is why 13 farmers were interviewed in order to get the data about their farms, families and problems they face. The average farm has about 1 ha pond area, 4 family members and income connected with fisheries about 70% of total income. The owner is an artisan in his forties who sells about three tons of fish per year primarily through restaurant and sport fishing, as in present situation on the fish market it became obvious that persisting only on fish culture is the most difficult way to earn money. In building the ponds the rules of landscape architecture should be respected together with those of fishery science. It would be necessary to offer the farmers better conditions in bank loans to start their business as well as to reduce many taxes, which they have to pay. The Croatian Agricultural Extension Service should be organized better to serve those farmers.

KEYWORDS: **family, fish farm, Croatia, sport fishing**

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THE ANALYSIS OF SMALL FAMILY COMMERCIAL FISH FARMS IN CROATIA

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DETAILED ABSTRACT

This paper deals with the results of our visits to 13 small family commercial fish farms. At each of them we interviewed the farmers with the same questionnaire in the first half of 1999. The questions were divided into several groups giving the answers about the ponds, family, the way of fishery managing and the principal problems that the farmers face in their everyday work.

The investigated farms are mainly situated in the northwestern part of Croatia (Fig. 1). All farms have pond area under or slightly over 1 ha, while only one has 7 ha. Half of the investigated farms have the salmonid and other half cyprinid water quality. All farms, except one, were built beside the roads and necessary supplies. The necessary equipment on most farms is good.

The basic occupation of the owner is predominantly artisan of different specialization. Half of them are in their forties years of life, while the range is from 28 to 60. The number of family members involved in the fish farm is usually between 3 and 5. The participation of the income connected with the fisheries in the whole income of the family ranges from 60-100%.

In present situation on the fish market it became obvious that persisting only on fish culture is the most difficult way to earn money. That is why it is advised to the farmers to combine culture with restaurant and sport fishing (Fig. 2). In that case the shape of the ponds should be incorporated in the nature, respecting the rules of landscape architecture. Annual production per farm is between 1,5 t and 6 t of cultured fish; while from 0,5 t to 5 t is soled through angling.

The basic problems expressed by almost all farmers are the lack of suitable bank loans that could help them to develop their activities, then high taxes for all the licenses, use the water and veterinary service. The lack of quality domestic food is also mentioned, while the lack of continuous extension service is also obvious. That is why it would be necessary to organize courses for Croatian Agricultural Extension Service personnel to serve family fish farmers better and to employ fresh water fishery experts.

It is possible to conclude that in the hard times for agriculture and fisheries in the Central European area small family commercial fish farms could be one of the solutions, but as this type of business is at its beginning it needs much help from the experts as well as from the government.

KEYWORDS: family, fish farm, Croatia, sport fishing

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INTRODUCTION

After the transitional changes the freshwater aquaculture in all Central European region has been passing through important transformations. In most countries the production has fallen down to even only one third. Many farms stopped the production on big proportion of their ponds. As an example, the famous Institute in Szarvas reduced its capacities and stuff to almost one fifth (Treer, 1996; Varadi, 1996). These serious problems resulted in conference hold in Budapest in 1996 where the fishery experts from the region tried to find the solutions. One of the recommendations was to develop sport fisheries which has great significance in the developed world (Varadi, 1999).

The similar process has been occurring in Croatia since the economic and political changes in 1990. The freshwater fish production dropped from 12000 tons to only 4000 tons (Turk, 1998). In the same time significant opposite process has been occurring in small family aquaculture. While before these changes Croatia had only one private carp farm and just few trout ones in recent years tremendous interest among farmers to create their own farms raised. However, most of them suffered in the lack of information, not knowing the basic principles of how to build and run such farm. Many of these farms are therefore made and run voluntarily, so our attempt was to establish contacts with such farmers, collect the data about their farms and to advise them in their further work.

MATERIALS AND METHODS

This paper deals with the results of our visits to 13 small family commercial fish farms. At each of them we interviewed the farmers with the same questionnaire. The questions were divided into several groups giving the answers about the ponds, family, the way of fishery managing and the principal problems that the farmers face in their everyday work.

The farmers were interviewed in the first half of 1999. The contacts with some of the farms were established even before and are kept now with all of them, continuously developing the cooperation with the other farms, too.

RESULTS

The investigated farms are mainly situated in the northwestern part of Croatia (Fig. 1). All of them were formed in nineties or late eighties. All farms have pond area under or slightly over 1 ha, while only one has 7 ha. Half of the investigated farms have the salmonid and other half cyprinid water quality. The ponds are filled either from the origin of the spring, either by the water few kilometers from it. One farm has only pit water. The depth of the cyprinid ponds is usually around 2,5 m or more up to 4 m, while the one of salmonid ponds is around 1 m. The farms were built beside the roads and necessary supplies (water, electricity). Only one is about 100 m far from them. The necessary equipment on most farms is good. The way of guarding the ponds if different. The owners live on four farms. Others are guarded by other members of the family (parents, brother), by paid guard, by dogs, only fence or not guarded at all.

The basic occupation of the owner is predominantly artisan of different specialization (two of them are qualified fish workers). Two owners

Figure 1.
The location of investigated farms in Croatia (numbers indicate the family names of the owners):

1- Posavec
2- Petko
3- Vranešić
4- Šaravanja
5- Krajačević
6- Grđan
7- Drempetić
8- Deško
9- Delišimunović
10- Vrabac
11- Kundić
12- Borić
13- Čikota

are retired and one is army officer. Half of them are in their forties years of life, while the range is from 28 to 60. The number of family members involved in the fish farm is usually between 3 and 5 (exceptionally 2 and 6). At the biggest farm all 11 family members are somehow included in the jobs connected with it. The participation of the income connected with the fisheries in the whole income of the family ranges from 60-100%. Three farms are just at the beginning now, yet without any income and the fourth one earns only 5%.

The way of managing fisheries in most cases is through sport fishing or combining it with aquaculture (Fig. 2). The anglers have to pay the all fish caught depending to weight. Only three farms are devoted just to fish culture. In that being the case one farm has the culture connected to the own restaurant, another is in the process of foundation, while the only one that exclusively sells to the market faces the problems with selling. The restaurants are established at two of other farms, too.

Annual production per farm is between 1,5 t and 6 t of cultured fish; while from 0,5 t to 5 t is soled through angling. One of the farms intensively produces rainbow trout in amount of 40 t per year and sells it to the Zagreb market. Other cultured fish are soled locally, exported to Italy or through own restaurant. Some farmers start culture with one-month-old fish, while the others start with pre consumable size (trout around 140 g, carps nearly 300 g). One farm tries only with the culture of carp fingerlings that could be soled to bigger farms for further culture. The carp at these farms is fed with grains and trout with pelleted food as is the practice on big farms. Besides the common carp the cyprinid farms usually have grasscarp, bighead, silver carp, pike, European catfish and brown bullhead.

The basic problems expressed by almost all farmers are the lack of suitable bank loans that could help them to develop their activities, then high taxes for all the licenses, use the water and veterinary service. The lack of quality domestic food is also mentioned, while the lack of continuous extension service is also obvious.

There are also some alternative attempts to earn some money for the family from fisheries. One retired soldier cultures the rainbow trout in cages in the river Cetina in Dalmatia. He produces about 2 t of fish annually selling them mostly to sport fishermen who visit the river. In other case the farmer leased the bog and organized commercial sport fishing there.

Fig. 2: The pond of Grđan fish farm

DISCUSSION

The significant economical and political changes that affected Croatia in last decade influenced the approach of small family farmers to fisheries as well. Many of them have been trying to earn part of their income by building the ponds and keeping the fish. Most of them started that job without any knowledge and experience, so facing the problems in building the ponds and keeping the fish in them.

In present situation on the fish market it became obvious that persisting only on fish culture is the most difficult way to earn money. That is why it is advised to the farmers to combine culture with restaurant and sport fishing. Moreover, only sport fishing or combination of it with the restaurant in the most cases could be the best solution. In that case the shape of the ponds should not be rectangular like it is on big farms. It should be incorporated in the nature, respecting the rules of landscape architecture (Jungwirth et al., 1995).

Almost all the farmers started with this enterprise faced serious money problems. It is very expensive to get all the licenses, to build the ponds and to buy fish and food. It would be necessary to offer the farmers better conditions in bank loans to start their business. Also, later on the taxes for water use and services are too high and should be reduced.

The Croatian Agricultural Extension Service has the branch for fisheries, but it is not equipped with the skilled personnel in the field. The stuff consists of faculty educated agriculturists, but they don't have experience in fisheries. That is why it would be necessary to organize courses for them to serve family fish farmers better and to employ fresh water fishery experts.

It is possible to conclude that in the hard times for agriculture and fisheries in the Central European area small family commercial fish farms could be one of the solutions, but as this type of business is at its beginning it needs much help from the experts as well as from the government.

LITERATURE

Jungwirth M., Muhar S., Schmutz S. (1995): The effects of recreated instream and ecotone structures on the fish fauna of an epipotamal river. Hydrobiologia, 303: 195-206

Treer T. (1996): Problemi slatkovodne akvakulture u zemljama u tranziciji (The problems of fresh-water aquaculture in the countries in transition). Book of papers, 24-26, Fish farming days, Osijek – in Croatian

Turk M. (1998): Hrvatsko slatkovodno ribarstvo u godini 1997. Ribarstvo, 56: 101-113

Varadi L. (1996): Hungary: National report on fish farming industry. Handbook of short communications and national reports, 133-138, Future trends of aquaculture development in Eastern Europe, Budapest

Varadi L. (1999): Possibilities and limitations of fish farmnig in the Republic of Hungary. Book of abstracts, 12, Fish farming days, Osijek

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FLEA BEETLES (CHRYSOMELIDAE: ALTICINAE) SPECIES OCCURRING ON AMARANTHUS spp. IN SLOVAKIA

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ABSTRACT

Occurrence and abundance of flea beetle species associated with *Amaranthus* spp. was studied in Slovakia with the aim to assess their potential as biological control agents. Insects were collected by sweeping/catching at 10 localities three times during the growing season. Together 13 species from the subfamily Alticinae were collected on *A. retroflexus* L. and *A. caudatus* L. plants by sweeping net. They were *Altica oleracea* (L.), *Chaetocnema concinna* (Marsh.), *C. leavicolis* Thoms., *C. tibialis* (Ill.), *Longitarsus longipennis* Kutsch., *L. melanocephalus* Deg., *L. nasturtii* (F)., *L. pellucidus* Foudras, *Phyllotreta atra* (F.), *P. cruciferae* (Goeze), *P. nigripes* (F.), *P. vittula* (Redt.) and *Psylliodes chrysocephala* (L.). *C. tibialis* contained 41.17- 97.45 percent of all flea beetles population and it was found at all observed localities. It comprised 94.85-99.74 percent of flea beetles on cultivated *A. caudatus.* Another two *Chaetocnema* species, *C. concinna* and *C. leavicollis* did not overcome more than one percent of *C. tibialis* population. *P. vittula* was present at each locality. All the other species occurred on *Amaranthus* plants were probably concomitant. Species composition of subfamily Alticinae on cultivated species *A. caudatus* did not differ significantly from those on *A. retroflexus.*

KEYWORDS: *Amaranthus,* biological control, flea beetles, Alticinae

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Introduction

Amaranthus spp. belong to the most important weeds in Europe [25], including Slovakia [6]. It was the reason why this weed was chosen for biological control research within the framework of COST (European Cooperation in the Field of Scientific and Technical Research) – Action [17]. The aim of the *Amaranthus* working group was to study potential biological control agents.

The pigweed flea beetle *Disonycha glabrata* (F.) was found suppressing pigweeds in South America [2, 30] and this species is still being promoted as a biological control agents in warm areas of U.S.A. [29].

In the Paleartic, most flea beetle species belong to cosmopolitan genera *Altica*, *Aphthona*, *Chaetocnema*, *Epitrix*, *Longitarsus*, *Neocrepidodera*, *Phyllotreta* and *Psylliodes*. Many of them are economically important pests. Some are considered highly beneficial for their role in suppressing noxious weeds [13]. According to literature in Europe, only *Chaetocnema tibialis* (Ill.) was reported as a host for *Amaranthus hybridus* and *A. retroflexus* [7, 20].

The aim of this study was to collect information on occurrence and abundance of flea beetle species associated with *Amaranthus retroflexus* L. in Slovakia. Because cultural species of *Amaranthus* are also grown in Slovakia (even on small areas), the surveys on *Amaranthus caudatus* L. – a cultural species, were conducted in the same time.

Methods

In 1995-1997, field surveys of flea beetles (Chrysomelidae: Alticinae) associated with *Amaranthus retroflexus* L. (wild species) and *Amaranthus caudatus* L. (cultivated species) plants were carried out in the first week of July, August and September at 10 localities from different climatic regions of Slovakia characterised according to Konèek [12]. The characteristic of surveyed localities is in Table 1a.

Table 1a. Characteristic of localities regularly surveyed in the study

Locality	Geographic coordinates	Relief	Altitude (m)	Climatic region [12]
Trebišov	48°36´N 21°43´E	Plain	109	warm, temperate dry
Neded	48°01´N 17°58´E	Plain	111	warm, dry
Kamenica nad Hronom	47°50´N 18°44´E	Hilly	117	warm, dry
Nitra – Janíkovce	48°18´N 18°08´E	Plain	135	warm, temperate dry
Vranov	48°51´N 21°43´E	Hilly	145	warm, temperate wet
Nitra – Malanta	48°19´N 18°09´E	Hilly	180	warm, temperate dry
Bátka	48°23´N 20°12´E	Hilly	200	warm, temperate dry
Sliaè	48°08´N 19°08´E	Basin	300	warm, temperate wet
Spišské Podhradie	49°00´N 20°47´E	Basin	435	cold
Liptovský Hrádok	49°03´N 19°44´E	Basin	654	cold

Insects were collected by sweeping/catching (3 x 25 randomly chosen plants). Because *Amaranthus* plants were different in size, a stem length of 1m was used as the "standard plant ".

Collected insects were put to death, sorted and identified.

Adults of *C. concinna* and *P. vittula* were put in Petri dishes together with the leaves of *A. retroflexus* and *A. caudatus.* During seven days the Petri dishes were checked for the damage of leaves caused by feeding of flea beetles.

Results

Together 13 species from the subfamily Alticinae were collected on *A. retroflexus* and *A. caudatus* plants by sweeping net in Slovakia. They were *Altica oleracea* (L.), *Chaetocnema concinna* (Marsh.), *C. leavicolis* Thoms., *C. tibialis* (Ill.), *Longitarsus longipennis* Kutsch., *L. melanocephalus* Deg., *L. nasturtii* (F)., *L. pellucidus* Foudras, *Phyllotreta atra* (F.), *P. cruciferae* (Goeze), *P. nigripes* (F.), *P. vittula* (Redt.) and *Psylliodes chrysocephala* (L.).

Genus *Chaetocnema* was predominated almost at each locality. The most numerous species was *C. tibialis* (Table 1).

Table 1. Number of *Chaetocnema tibialis* (Ill.) adults on *Amaranthus retroflexus* L. and *Amaranthus caudatus* L. (only at the locality Nitra – Malanta*) plants at different localities of Slovakia during 1995-1997. Insects were collected by sweeping net on 75 plants.

Year	1995			1996			1997		
Month	July	August	Sept.	July	August	Sept.	July	August	Sept.
Locality									
Trebišov	8	7	11	20	91	20	22	22	6
Neded	125	76	52	7	7	25	19	4	0
Kamenica nad Hronom	45	209	36	273	502	163	12	5	0
Nitra – Janíkovce	6	30	80	15	210	74	8	5	8
Vranov	4	3	7	14	29	16	3	0	0
Nitra –Malanta*	31	86	79	213	30	4	6	25	2
Nitra – Malanta	3	318	84	7	237	52	3	1	0
Bátka	41	157	78	2	36	6	5	4	1
Sliaè	10	162	23	2	5	0	2	1	0
Spišské Podhradie	0	1	9	5	3	3	3	2	7
Liptovský Hrádok	3	1	4	1	0	6	2	1	2

In the west of Slovakia the population of this species was higher than it was in the east of Slovakia. *C. tibialis* contained 41.17-97.45 percent of all flea beetles population and it was found at all observed localities. Another two *Chaetocnema* species, *C. concinna* and *C. leavicollis* did not overcome more than one percent of *Ch. tibialis* population.

Phyllotreta sp. was the second numerous genus observed on *A. retroflexus* plants. *P. vittula* was the most abundant species within of this genus (Table 2) and the number of individuals ranged from 4.25 to 70.00 percent of flea beetles population.

Table 2. Number of *Phyllotreta vittula* (Redt.) adults on *Amaranthus retroflexus* L. and *Amaranthus caudatus* L. (only at the locality Nitra – Malanta*) plants at different localities of Slovakia during 1995-1997. Insects were collected by sweeping net on 75 plants.

Year	1995			1996			1997		
Month	July	August	Sept.	July	August	Sept.	July	August	Sept.
Locality									
Trebišov	14	1	7	41	44	2	10	2	1
Neded	7	2	11	0	2	9	2	2	1
Kamenica nad Hronom	5	0	8	69	1	7	14	4	1
Nitra - Janíkovce	1	2	8	3	3	3	6	1	0
Vranov	5	4	3	11	23	0	1	1	0
Nitra – Malanta*	0	0	0	4	2	1	1	0	0
Nitra - Malanta	6	8	3	2	17	0	3	0	0
Bátka	1	1	17	1	1	1	5	0	0
Sliaè	3	2	7	2	12	0	2	1	0
Spišské Podhradie	0	2	0	0	16	10	0	0	0
Liptovský Hrádok	0	1	4	0	4	2	1	0	0

Its occurrence was higher in the east of Slovakia during 1995-96. The species was present at each locality. In 1997 the population was relatively high also in the west of Slovakia, but it was not found at cold locality of east Slovakia – Spišské Podhradie.

Laboratory tests showed that *C. tibialis* adults fed on *A. retroflexus* and *A. caudatus* leaves. The adults of *P. vittula* did not feed the leaves of both amaranth species.

P. atra was collected at 9 from 11 observed localities (Table 3) and its population did not exceeded 7.32 percent of flea beetle population.

Table 3. Number of *Phyllotreta atra* (F.) adults on *Amaranthus retroflexus* L. and *Amaranthus caudatus* (only at the locality Nitra – Malanta*) plants at different localities of Slovakia during 1995-1997. Insects were collected by sweeping net on 75 plants.

Year	1995			1996			1997		
Month	July	August	Sept.	July	August	Sept.	July	August	Sept.
Locality									
Trebišov	0	0	0	2	5	0	0	0	0
Neded	0	0	1	0	0	1	0	0	0
Kamenica nad Hronom	0	0	0	7	0	0	0	0	0
Nitra - Janíkovce	0	0	0	1	0	0	1	0	0
Vranov	0	0	0	0	0	0	0	0	0
Nitra – Malanta*	0	0	0	8	2	2	0	0	0
Nitra – Malanta	4	17	4	4	0	0	0	1	0
Bátka	0	0	0	0	3	0	0	0	0
Sliaè	0	0	0	0	1	0	0	0	0
Spišské Podhradie	0	0	0	0	1	0	0	0	2
Liptovský Hrádok	0	0	0	0	0	0	0	0	0

P. nigripes was found only randomly and its maximum proportion was 0.85 percent of flea beetles population. *P. cruciferae* was observed once during three years at locality Nitra - Malanta (Table 5).

L. pellucidus was common *Amaranthus* plants (Table 4) in Slovakia. It occurred at all localities, except of Neded (west of Slovakia).

Table 4. Number of *Longitarsus pellucidus* Foudras adults on *Amaranthus retroflexus* L. and *Amaranthus caudatus* (only at the locality Nitra – Malanta*) plants at different localities of Slovakia during 1995-1997. Insects were collected by sweeping net on 75 plants.

Year	1995			1996			1997		
Month	July	August	Sept.	July	August	Sept.	July	August	Sept.
Locality									
Trebišov	0	0	0	0	1	1	0	0	1
Neded	0	0	0	0	0	0	0	0	0
Kamenica nad Hronom	0	0	1	0	1	0	0	1	0
Nitra – Janíkovce	0	0	0	0	0	0	0	1	0
Vranov	0	0	0	0	1	0	0	0	0
Nitra – Malanta*	0	0	0	0	1	1	1	1	0
Nitra – Malanta	0	1	0	0	0	0	0	2	0
Bátka	0	3	0	0	0	1	0	0	0
Sliaè	0	0	0	3	0	5	0	0	0
Spišské Podhradie	0	0	0	0	1	0	0	0	0
Liptovský Hrádok	0	0	0	0	1	0	0	0	3

The highest numbers of *L. pellucidus* were observed in Sliaè (18.6% of all flea beetles collected) and Liptovský Hrádok (33.3%). The other *Longitarsus* species (*L. longipennis*, *L. melanocephalus*, *L. nasturtii*) were present on a few localities in a small scale (Table 5).

Table 5. Number of adults of seven Alticinae species on *Amaranthus retroflexus* L. and *Amaranthus caudatus* (only at the locality Nitra – Malanta*) plants at different localities of Slovakia during 1995-1997. Insects were collected by sweeping net on 75 plants. PN – *Phyllotreta nigripes* (F.), PC - *Phyllotreta cruciferae* (Goeze), PH - *Psylliodes chrysocephala* (L.), AO - *Altica oleracea* (L.), LN - *Longitarsus nasturtii* (F.), LM - *Longitarsus melanocephalus* Deg., LL - *Longitarsus longipennis* L.

Year	1995			1996			1997		
Month	July	August	Sept.	July	August	Sept.	July	August	Sept.
Locality									
Trebišov	0	AO	LN	0	0	0	PN	0	AO
Neded	0	AO	AO	0	LN	LN	0	0	0
Kamenica nad Hronom	0	LN	0	0	AO	0	0	0	0
Nitra – Janíkovce	0	0	0	PH	0	0	0	0	0
Vranov	PH	PH	PH	0	LM	0	0	0	PH
Nitra – Malanta*	0	0	0	PN	PC	0	PN	0	PH
Nitra – Malanta	PN	PN	0	PN	AO	AO	0	0	AO
Bátka	0	0	LN	0	0	0	0	0	0
Sliaè	0	0	0	0	0	0	0	0	0
Spišské Podhradie	0	0	0	0	0	0	0	0	AO
Liptovský Hrádok	LL	0	0	0	0	0	0	0	0

A. oleracea and *P. chrysocephala* were found randomly at some localities (Table 5).

Species composition of subfamily Alticinae on cultivated species *Amaranthus caudatus* did not differ significantly from those on *A. retroflexus* at Nitra- Malanta locality. Predominating species on cultivated species was *C. tibialis*, which formed 94.85-99.74 percent of all flea beetles (Table 1). The species that occurred in a low numbers were *L. pellucidus*, *P. vittula*, *P. atra*, *P. nigripes* and *P. chrysocephala* (Tables 1, 4, and 5).

In average the number of flea beetles species was much lower in 1997 than in previous years. In 1997, high amount of precipitation was observed in July.

Discussion

Of the 13 *Alticinae* flea beetles collected on *Amaranthus* plants only *C. tibialis* and *P. vittula* were found regularly at all observed localities.

From the literature it is known that amaranth plants serve as a host for *C. tibialis* [2, 20, 21]. However, *C. tibialis* is a serious pest of sugar beet in Czech republic and Slovakia (former Czechoslovakia) [22], Portugal [19], Bulgaria [27], or in Turkey [32].

C. concinna is also the pest of sugar beet [4, 16]. During our survey it was present in a very small number on amaranth plants and for that reason the possible damages are economically not important. *C. concinna* and *C. laevicollis* seem to be more important in more wet and cold regions of Europe. Schmidt [24] indicated *C. concinna* as north European sugar beet flea beetle and *C. tibialis* as south European sugar beet flea beetle. *C. concinna* is the most important flea beetle in Great Britain [8].

P. vittula was reported as important pest of cereals [9, 18] and maize [26, 28]. This gives a reason for their higher number on weedy amaranth in maize crop than on cultivated species grown as monoculture. On the other hand, *P. vittula* was reported as a pest of crucifers and sugar beet [18]. It was found feeding on yellow mustard [11]. According to literature it seems that *P. vittula* is relatively polyphagous, but in our laboratory tests it did not feed on amaranth leaves.

All the other species occurred on *Amaranthus* plants were probably concomitant.

P. cruciferae is usual flea beetle on cruciferous plants of central Europa [10, 31]. It is the most abundant at the places of high population densities of *Brassica* spp. [5]. Probably this requirement caused its scarcity on *Amaranthus* plants.

P. atra [10, 14] and *P. nigripes* [14] also attack cruciferous crops. They were found at 9 localities in a small number on *Amaranthus* plants. They are probably common insects in Slovak conditions able to exist not only on cultural but also on wild *Cruciferae. P. chrysocephala* is also usual on *Cruciferae* and its occurrence on *Amaranthus* was probably accidental.

L. pellucidus was usual insect collected on *Amaranthus* plants in Slovakia. According to literature, *L. pellucidus* is associated with *Convolvulaceae* [1, 15, 23]. Their presence on *Amaranthus* plants is temporary or because of climbing of *Convolvulus arvensis* on them. *C. arvensis* was often found to climb on *Amaranthus* plants. The host plant of *L. longipennis* is *C. arvensis* [31] and its occurrence on amaranth was probably only accidental. Similarly, host plants of *L. melanocephalus* are plants from the genus *Plantago* [10], and the host plants of *L. nasturtii* are Boraginaceae [10, 31].

A. oleracea is usual on cruciferous plants, and it is dangerous pest of rape [10]. But, it lives on the plants from family Polygonaceae like it is in case of *C. concinna* [31].

Our results showed that flea beetles species, which occurred on wild amaranth, were found also on cultivated species. It is clear that flea beetles occurring on amaranth plants in Slovakia are the pests of cultural crops. Even more, they do not distinguish between wild and cultural amaranth. Probably the same situation could develop when any insect species will be introduced from America.

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Detailed abstract in Slovak

Výskum zameraný na zistenie výskytu a poèetnosti skoèiek viazaných na druhy z rodu *Amaranthus* sa uskutoènil na Slovensku v rokoch 1995 - 1997 s cie¾om stanovi• ich potenciál z poh¾adu biologickej ochrany. Hmyz bol zbieraný metódou smýkania na 10 lokalitách, ktoré sa sledovali trikrát poèas vegetaèného obdobia. Na druhoch *Amaranthus retroflexus* L. a *A. caudatus* L. bolo zaznamenaných spolu 13 druhov z podèe¾ade Alticinae. Patrili k nim *Altica oleracea* (L.), *Chaetocnema concinna* (Marsh.), *C. leavicolis* Thoms., *C. tibialis* (Ill.), *Longitarsus longipennis* Kutsch., *L. melanocephalus* Deg., *L. nasturtii* (F)., *L. pellucidus* Foudras, *Phyllotreta atra* (F.), *P. cruciferae* (Goeze), *P. nigripes* (F.), *P. vittula* (Redt.) a *Psylliodes chrysocephala* (L.). *C. tibialis* tvorila v závislosti od lokality 41.17-97.45 % z populácie všetkých skoèiek a bola zaznamenaná na ka•dej sledovanej lokalite. Na kultúrnom druhu *A. caudatus* predstavovala 94.85-99.74 % zo všetkých skoèiek. Ïalšie dva druhy z rodu *Chaetocnema*, *C. concinna* a *C. leavicollis* netvorili viac ako jedno percento z populácie *C. tibialis*. Rod *Phyllotreta* bol pozorovaný ako druhý najpoèetnejší. *P. vittula* sa vyskytovala na ka•dej lokalite a jej zastúpenie sa pohybovalo od 4.25 do 70.00 % z populácie všetkých skoèiek. Všetky ostatné druhy zaznamenané na rastlinách z rodu *Amaranthus* boli pravdepodobne iba sprievodnou faunou. Druhové zlo•enie podèe¾ade Alticinae na kultúrnom druhu *A. caudatus* sa podstatne nelíšilo od druhového spektra zaznamenaného na burinnom druhu *A. retroflexus* na lokalite Nitra - Malanta. Prevládajúcim druhom bola *C. tibialis*. Druhy *L. pellucidus*, *P. vittula, P. atra*, *P. nigripes* a *P. chrysocephala* sa objavovali v menších mno•stvách.

References

[1] Balachowsky, A. S. (1963) Entomologie appliquée a l´agriculture. Tome I. Coléopteres. Masson et Cie Editerus, 2 vol., Paris.

[2] Balsbauch, E. U. Jr., Frey, R. D., Scholl, C. G., Anderson, A. W. (1981) Insect for weed control: status in North Dakota. Nort Dakota Farm Research, 39 (3): 3-7.

[3] Bürki, H. M., Schroeder, D., Lawrie, J., Cagáò, ¼., Vráblová, M., El Aydam, M., Szentkirályi, F., Ghorbani, R., Jüttersonke, B., Ammon, H.U. (1997) Biological control of pigweeds (*Amaranthus retroflexus* L., *A. powellii* S. Watson and *A. bouchonii* Thell.) with fytophagous insect, fungal pathogens and crop management. Integrated Pest Management Reviews, 2: 51-59.

[4] Cooke, D.A. (1992) Pest of sugar beet in the UK. Agricultural Zoology Reviews, 5: 97-137.

[5] Cromartie, W.J. (1975) The effect of stand size and vegetation background on the colonization of cruciferous plants by herbivorous insect. Journal of Applied Ecology, 12: 517-553.

[6] Èernuško, K., Líška, E., Týr, Š., Fábri, A. (1999) Buriny a burinné trávy. BASF Bratislava, 174.

[7] Doguet, S. (1994) Faune de France, part 80. Coléopteres *Chrysomelidae* Vol. 2 *Alticinae*. Fédération Française des Societes de Sciences Naturelles, Paris, France, 649 pp.

[8] Dunning, R. A. (1974) Arthropod pest damage to sugar beet in England and Wales. 1947-74. Report, Rothamsted Experimental Station. Part 2, 171-185.

[9] Evdokimov, N.Ya., Korchagin, A. A. (1984) Regulating the abundance of pests. Zashchita Rastenii, 9: 27-28.

[10] Freude, H., Harde, K. W., Lohse, G. A. (1966) Die Käfer Mitteleuropas. Band 9. Cerambycidae, Chrysomelidae, Goecke Evers Verlag, Krefeld, 299 pp.

[11] Hurej, M., Preiss, G., Debek, J. (1997) Species composition and occurrence of flea beetles on yellow mustard in Lower Silesia, Poland. Polskie Pismo Entomologiczne, 66 (3-4): 311-317.

[12] Konèek, M. (1980) Klimatické oblasti. In: Atlas Slovenskej socialistickej republiky. Bratislava: SAV, 64.

[13] Konstantinov, A. S., Vandenberg, N. J. (1996) Handbook of Paleartic Flea Beetles (Coleoptera: Chrysomelidae: Alticinae). In: Contributions on Entomology, International, 1 (3): 439.

[14] Kostromitin, V. B. (1978) Damage by crucifer flea-beetle. Zashchita Rastenii, 7: 36.

[15] Lesage, L. (1988) Notes on European *Longitarsus* species introduced in North America (Coleoptera: Chrysomelidae: Alticinae). Canadian Entomologist, 120 (12): 1133-1145.

[16] Mostovaya, R. N. (1994) Distribution by habitats of the chief pests in a rotation. Sakharnaya Svekla, 9: 13-14.
[17] Müller-Schärer, H. (1993) Biological control of weeds in crops: a proposal of a new COST action. In: Maitrise des adventises par voie non chimique. IFOAM Conference, Dijon, 181-185.
[18] Naibo, B. (1974) Damage by the flea-beetle *Phyllotreta vittula* Redt. on maize. Revue de Zoologie Agricole et de Pathologie Vegetale, 73 (2): 70-72.
[19] Neves, E. F. (1983) On the insect fauna of sugarbeet in Portugal. Boletim da sociedade portuguesa de Entomologia, 2 (37): 77-94.
[20] Nonveiler, G. (1960) Štetni buvaèi kulturnog i drugog korisnog bilja Srbije (Halticinae, Fam. Chrysomelidae, Coleopt.), Institut za zaštitu bilja, Beograd, 37-43.
[21] Nonveiler, G. (1978) Les Altises de Serbie et Leurs Planteshotes (Chrysomelidae, Coleoptera). 1. Le genere *Chaetocnema* Steph. Extrait du Recueil des travaux sur la faune d´insectes de la Serbie, t. 2, De l´Academie Serbe des Sciences et des Art, Beograd, 91-111.
[22] Øimsa, V., Koneèný, I. (1983) Sugar-beet seedling pests and diseases: present and future control in Czechoslovakia. 10th International Congress of Plant Protection 1983. Volume 3. In: Proceedings of a conference held at Brighton, England, 20-25 November 1983. Plant Protection for Human Welfare, 1208.
[23] Rosenthal, S. S., Buckingham, R. G. (1982) Natural enemies of *Convolvulus arvensis* in western Mediterranean Europe. Hilgardia, 5 (2): 1-19.
[24] Schmidt, M. (1962) Landwirtschaftlicher Planzenschutz. Deutcher Bauernverlag Berlin, 469-470.
[25] Schroeder, D., Müller-Schärer, H., Stinson, C. S. A. (1993) A European weed survey in 10 major crop systems to identify targets for biological control. Weed Research, 33 (6): 449-458.
[26] Sekuliæ, R., Èamprag, D., Keresi, T., Talosi, B. (1989) A contribution to the knowledge of some species of *Coleoptera* in corn fields in Yugoslavia. Acta Phytopathologica et Entomologica Hungarica, 24 (1-2): 189-193.
[27] Slavchev, A. (1984) Protection of sugarbeet against pests. Rastitelna Zashchita, 32 (2): 20-23.
[28] Szoeke, K. (1997) Damage of millet flea-beetle on spring barley and maize. Novenyvedelem, 33 (1): 33-34.
[29] Tisler, A. M. (1990) Feeding of the pigweed flea beetle, *Dysonych glabrata* Fab. (Coleoptera: Chrysomelidae), on *Amaranthus retroflexus.* Virginia Journal of Science, 41 (3): 243-245.
[30] Vogt, G., Cordo, H. A. (1976) Recent South American field studies of prospective biocontrol agents of weeds. In: Proceedings of Research Planning Conference on the Aquatic Plant Control Programme, Charleston, 36-55.

[31] Warcha³owski, A. (1978) Klucze do oznaczania owadów Polski. Czeœæ XIX, Zeszyt 94c, Warszawa, Wroclaw, Pañstvove Wydawnictwo Naukowe, 157 pp.
[32] Yildirim, E., Ozbek, H. (1992) Insect fauna of sugarbeet growing areas of Erzurum Sugar Factory. In: Proceedings of the Second Turkish National Congress of Entomology, 621-635.

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WATER EROSION IN DIFFERENT CROP DEVELOPMENT STAGES AND TILLAGE PRACTICES ON LUVIC STAGNOSOL OF CENTRAL CROATIA

EROZIJA TLA VODOM U UZGOJU RAZLICITIH USJEVA PRI RAZLICITIM ZAHVATIMA OBRADE NA PSEUDOGLEJU SREDIŠNJE HRVATSKE

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ABSTRACT

Water erosion was recorded during a four-year period (1994-1998.) on Luvic stagnosol (pseudogley), in the Daruvar area (Central Croatia), in different crop development stages according to USLE, under six tillage treatments in growing common arable crops in the common crop sequence. A much higher rate of erosion, higher than Soil loss tolerance (T value) was recorded in the growing of spring crops (row crops) than in winter crops of high plant density, where it was below the T value. In the growing of spring crops, the critical period with maximal water erosion was the period of seedbed preparation (SB period according of USLE), the period just after sowing. In the growing of maize and soybean, this is the period when over 80% of the overall annual erosion occurs in all tillage variants. As expected, the maximal rate of soil erosion, higher than the T value, was recorded in the standard plot according to USLE, followed by the variant of conventional up/down the slope tillage. Soil erosion was much smaller and below the T value in the no-tillage variant and in all variants with tillage across the slope. This means that these variants of soil tillage can be defined as conservation tillage in agroecological conditions of this part of Croatia. In growing winter crops of high density (wheat and oil seed rape), no critical periods were observed and erosion was much below the T value and was uniformly distributed throughout the whole growing season. According to the results, to reduce soil erosion below the T value on slopes of inclination higher than 9%, soil conservation practices are all tillage operations across the slope and/or a reduced crop rotation, without row crops.

KEYWORDS: Water erosion, Crop development stages, Conservation tillage, Soil loss tolerance – T value.

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EROZIJA TLA VODOM U UZGOJU RAZLICITIH USJEVA PRI RAZLICITIM ZAHVATIMA OBRADE NA PSEUDOGLEJU SREDIŠNJE HRVATSKE

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SAŽETAK

Tijekom četvorogodišnjeg razdoblja (1994-98) na pseudogleju središnje Hrvatske pri različitim varijantama obrade tla istraživana je erozija tla vodom. U istraživanja su uključeni usjevi koji dominiraju u ovom podneblju, dok su varijante obrade slijedeće: 1. Standardna parcela prema USLE - crni ugar 2. Konvencionalno oranje (do 25 cm) uz i niz nagib 3. Izostavljanje obrade - izravna sjetva, 4. Konvencionalno oranje okomito na smjer nagiba 5. Vrlo duboko oranje (do 50 cm) okomito na smjer nagiba. 6. Podrivanje na 60 cm dubine + konvencionalno oranje okomito na smjer nagiba.

Temeljem polučenih rezultata i odnosa s tolerantnom erozijom za ovaj tip tla zaključujemo da su erozijski nanosi pri u uzgoju jarina rijetkog sklopa (kukuruz i soja) mnogo veći u odnosu na tolerantno odnošenja za ovaj tip tla. Kritično razdoblje pri uzgoju ovih kultura je neposredno poslije sjetve ovih usjeva (razdoblje nicanja pa dok usjev nije prekrio 10% površine). U ovom razdoblju utvrđeno je preko 80 % ukupne godišnje erozije, bez obzira na smjer obrade. Pri uzgoju ozimih kultura gustog sklopa (pšenica i uljana repica) nisu zabilježeni kritična razdoblja, dok je ukupna erozija izrazito niža od tolerantnog odnošenja, pa u obzir dolaze svi istraživani načini obrade tla.

Temeljem svega navedenog zaključujemo da je obrada uz/niz nagib pri uzgoju jarina rijetkog sklopa visoko rizična na nagnutim terenima, pa bi taj način obrade tla trebalo napustiti. Izostavljanje obrade i bilo koji od načina obrade okomito na nagib preporučamo za širu primjenu u poljoprivrednoj proizvodnji. Smatramo da je riječ je o načinima obrade tla koji su u skladu s održivom poljoprivredom u ovom podneblju.

KLJUČNE RIJEČI: Erozija tla vodom, periodi razvoja usjeva, konzervacijska obrada, tolerantno odnošenje tla

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1. Introduction and investigation goal

The investigation goal is to determine the critical crop-stage periods and soil conservation practices on Luvic stagnosol (pseudogley) in the growing of common field crops. We search for the answer to the question whether it is possible to reduce water erosion to or below the Soil loss tolerance level (T value) by applying different soil tillage practices, crop management and crop sequence. Based on the results obtained, the optimal conservation tillage has to be determined for Luvic stagnosol, as a soil very prone to erosion.

The results should provide elements for recommending the optimal method of conservation tillage on Luvic stagnosol, as a very widespread soil type in this part of Europe.

2. Materials and methods

The stationary field trial was set up in the summer of 1994, after the oil seed rape harvest, on arable land of the farm "Poljodar" in Daruvar, central Croatia, on Luvic stagnosol [31]. Erosion was measured on 6 enclosed trial plots, according to the USLE propositions [30], viz. on a 9% slope, length 22.1 m, width 1.87 m, or a plot area of 41.3 m^2. Plots are enclosed by a sheet-metal fence, which is removed before each tillage operation, and then put up again after the operation is completed. The fence is set up so as to ensure that soil suspension cannot penetrate the trial plot from the sides or run off from the enclosed plot area. To facilitate the application of agricultural machinery, the trial variants are set 15 m apart, which allows for free and easy turning of a tractor with the longest trailing implement.

The experimental station consists of the following six treatments: ❶ Standard plot according to USLE, tilled up/down the slope. All tillage operations are applied in this variant (mouldboard to 30 cm deep, disc-harrowing, dragging), but it is unsown. ❷ Conventional (mouldboard) ploughing up/down the slope to 30 cm deep. Sowing and all the other agricultural practices commonly applied to relevant crops are performed in the same direction. ❸ No-tillage, sowing with a special seeder into dead mulch, up/down the slope. A week to two weeks before sowing, weeds are eradicated using total herbicides. ❹ Conventional (mouldboard) ploughing across the slope to 30 cm deep. ❺ Very deep ploughing across the slope (to 50 cm deep). In contrast to all other ploughing practices, which are done with multi-furrow ploughs, the single-furrow plough is applied in this treatment. ❻ Subsoiling to the depth of 60 cm, subsoiler working bodies set 70 cm apart, with conventional (mouldboard) ploughing across the slope to 30 cm deep. In the last three variants, sowing and all other agricultural practices are performed across the slope.

Special equipment enabling separation and filtration of soil suspension has been set up on the lower

part of each trial plot, clean water is collected in a separate container while solid drift remains on the cloth serving as filter.

Crops were grown on experimental plots in the following crop sequence: 1994/95 - maize (Zea mays), 1995/96 - soybean (Glycine hispida max), 1996/97 - winter wheat (Triticum aestivum), 1997/98 - oil seed rape (Brassica napus v. oleifera).

Crop development is monitored per stages of crop growing according to USLE [28] and [30]: Period F - rough fallow (ploughing to sowing); Period SB - seedbed (sowing to 10% of area covered by crop), Period 1 - establishment of crop (SB to 50% of area covered by crop); Period 2 – crop development (100% of area covered by crop); Period 3 – crop maturing (to harvest); Period 4 - residue or stubble (crop harvest to mouldboard ploughing or new sowing).

3. Results and discussion

3.1. Characteristics of the climate

Major long-term (1959-1998) indicators of climatic properties in the course of investigation are shown in Table 1. It is noticeable that the long-term precipitation mean amounts to 863 mm, with a monthly rain maximum in June.

TABLE 1. Long-term (1995-1998) rainfall distribution and average temperature of the Daruvar area

Period – Year		Total monthly, average monthly temperature (^{0}C), maximal daily and maximum 30 min. intensity of rain – mmn. intensity of rain – mm												Total, mm
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average ^{0}C
1995	**total monthly**	46	68	42	39	80	154	3	136	183	13	89	59	912
	average temp. ^{0}C	**1.1**	**6.6**	**5.4**	**11.6**	**15.2**	**18.2**	**23.3**	**19.4**	**14.8**	**11.6**	**4.3**	**1.7**	11.1
	max. daily rain, mm	**13.6**	**28.1**	**10.5**	**12.1**	**16.1**	**33.0**	**2.0**	**34.9**	**71.2**	**8.5**	**24.7**	**16.1**	
	max. 30 min. inten.	**3.1**	**3.6**	**4.7**	**3.0**	**8.7**	**11.7**	**0.5**	**26.7**	**14.9**	**2.3**	**2.4**	**1.3**	
1996	**total monthly**	75	24	24	65	94	40	93	37	226	45	109	60	893
	average temp. ^{0}C	**-1.3**	**-1.1**	**3.2**	**10.8**	**17.2**	**20.2**	**19.4**	**19.8**	**12.8**	**11.2**	**7.8**	**-1.2**	9.9
	max. daily rain, mm	**21.2**	**11.0**	**12.2**	**18.7**	**33.0**	**13.5**	**45.8**	**12.1**	**62.5**	**15.7**	**29.3**	**14.4**	
	max. 30 min. inten.	**1.9**	**1.7**	**1.2**	**3.0**	**12.9**	**11.1**	**9.5**	**8.1**	**8.9**	**3.6**	**5.0**	**1.2**	
1997	**total monthly**	47	55	23	43	66	91	112	79	22	64	106	64	771
	average temp. ^{0}C	**-1.5**	**0.6**	**3.1**	**8.4**	**15.1**	**16.1**	**17.9**	**19.9**	**15.9**	**10.9**	**5.7**	**1.6**	9.5
	max. daily rain, mm	**9.7**	**26.8**	**12.6**	**13.0**	**27.7**	**28.8**	**23.5**	**24.4**	**13.8**	**29.1**	**38.4**	**19.1**	
	max. 30 min. inten.	**2.3**	**2.5**	**1.4**	**2.9**	**3.8**	**17.2**	**12.4**	**8.0**	**4.0**	**9.7**	**2.3**	**3.8**	
1998	**total monthly**	62	5	64	69	75	100	82	84	114	119	77	47	898
	average temp. ^{0}C	**3.1**	**4.6**	**4.3**	**12.2**	**15.1**	**20.2**	**21.1**	**20.3**	**15.3**	**11.9**	**3.4**	**-2.9**	10.7
	max. daily rain, mm	**27.4**	**3.4**	**19.5**	**17.6**	**17.2**	**18.8**	**25.5**	**34.7**	**25.9**	**35.3**	**16.6**	**23.2**	
	max. 30 min. inten.	**1.9**	**0.8**	**2.6**	**4.6**	**4.3**	**10.0**	**19.6**	**9.0**	**4.6**	**8.2**	**3.1**	**0.7**	
Average, mm: 1959-1998		55	47	58	73	88	97	85	82	62	70	83	63	863
Average, ^{0}C: 1959-1998		-0.4	1.9	6.3	10.9	15.5	18.9	20.6	19.9	15.9	10.9	5.7	1.6	10.7

3.2. Properties of the soil

According to soil classification [31], the soil type of the experimental station is defined as Luvic stagnosol, formed on non-carbonate Pleistocene loam as parent material, with A_{ch}+E_{cg}–E_{cg}+B_{tg}–B_{tg} sequence of soil horizons. Due to its physical (high content of fine sand and loam) and chemical properties (calcium deficiency, low content of organic matter), this soil type is very erodible. Data from Table 2 indicate that this is a poorly porous to porous soil of a medium water holding capacity.

TABLE 2. Physical properties of the soil

Soil depth, cm	Soil horizon	Porosity, (% Vol.)	Water holding capacity, %	Air capacity, %	Specific density, g/cm^3	
					Bulk	Real
0-24	**Ach + Ecg**	**43.8**	**35.0**	**8.8**	**1.45**	**2.58**
24-35	**Ecg + Btg**	**43.3**	**35.4**	**7.9**	**1.43**	**2.52**
35-95	**Btg**	**41.8**	**39.1**	**2.6**	**1.52**	**2.61**

The soil is sandy loam in all horizons. It is characterized by a high content of fine sand and silt. Differences in clay content are not large and are generally a consequence of soil mixing through tillage. Clay content is increased in the B_{tg} horizon (Table 3).

TABLE 3. Soil texture

Soil horizon	Depth cm	% particle size distribution, mm				
		Coarse sand	Fine sand	Silt	Clay	Texture
$A_{ch}+E_{cg}$	0-24	1.8	58.6	24.2	15.4	Sandy loam -SL
$E_{cg}+B_{tg}$	24-35	4.1	55.1	26.0	14.8	Sandy loam- SL
B_{tg}	35-95	0.5	51.5	25.4	19.6	Sandy loam- SL

Soil reaction is very acid in the topsoil and acid in the B_{tg} layer (Table 4). Related to this, the soil is also of high hydrolytic acidity. There is a low humus content in the plough layer, soil supply of plant available phosphorus is medium, and of plant available potassium good.

TABLE 4. Chemical properties of the soil

Soil horizon	Depth cm	pH in nKCl	Humus, %	Hydrolytic acidity, Y_1	mg/100 g soil P_2O_5	K_2O
$A_{ch}+E_{cg}$	0-24	4.21	1.6	13.2	10.56	10.00
$E_{cg}+B_{tg}$	24-35	4.20	1.4	12.3	9.02	8.98
B_{tg}	35-95	4.81	0.6	5.0	5.69	6.18

3.3. Erosion in different tillage treatments and in growing different crops

Investigations were conceived so as to obtain the answer to the set investigation goal by applying adequate methods of basic soil tillage and of growing the main field crops. It is assumed that the differences that will occur in surface runoff and erosional drift will be directly dependent on the applied soil tillage methods and crops. The obtained results will serve as the basis for determining the tillage method that will most efficiently stop erosional processes, that is, reduce erosion risk in crop growing, protect the environment, at the same time sustaining or increasing the attained growing levels.

3.3.1. Erosion in the growing of row (spring) crops

Numerous studies conducted in the world, among which mention is made of only some of the authors, from North America – [15] and [19], South America – [9], Australia – [23], Asia – [20], Africa – [1], [4], [6], [17], [26]

and [27], and Europe - [2], [5], [14], [22] and [24], have proven that conventional up/down the slope ploughing and sowing is the least favourable tillage method, since it leads to highest erosion, whereas no-tillage and ploughing across the slope are much more efficient in terms of erosion control. This has also been confirmed by our investigations.

Row (spring) crops were grown in the first two investigation years (maize 1994/95 and soybean 1995/96). Erosion in those years was determined per different stages of crop development according to USLE and is shown in Table 5.

Table 5. Soil erosion in different crop-stages of row (spring) crops

Crop-stage	Standard plot (Black fallow)	Ploughing up/down the slope	No tillage	Ploughing	Very deep ploughing across the slope	Subsoiling +ploughing
			MAIZE GROWING			
Period SB – Seedbed (t/ha)	**34.74**	**28.86**	**18.48**	**9.54**	**18.80**	**2.69**
% of the rate	23.7	74.9	80.8	81.8	88.9	90.0
Period 1 – establishment (t/ha)	1.37	0.36	0.015	-	-	-
% of the rate	0.9	1.0	0.1			
Period 2 – development (t/ha)	**50.24**	**5.22**	**1.58**	**0.65**	**1.13**	**0.05**
% of the rate	34.3	13.5	6.9	5.6	5.4	1.8
Period 3 – maturing (t/ha)	**59.97**	**4.09**	**2.78**	**1.47**	**1.19**	**0.24**
% of the rate	41.1	10.6	12.2	12.6	5.7	8.2
Rate of erosion (t/ha)						
October 1994-October 1995	**146.32**	**38.53**	**22.86**	**11.66**	**21.12**	**2.99**
			SOYBEAN GROWING			
Period F - Rough fallow (t/ha)	**0.048**	**0.091**	**0.009**	**0.015**	**0.023**	**0.063**
% of the rate	0.1	0.2	0.1	0.3	0.5	2.2
Period SB – Seedbed (t/ha)	**32.41**	**37.43**	**13.4**	**5.13**	**4.89**	**2.54**
% of the rate	29.4	98.0	98.6	95.7	93.2	87.4
Period 1 – establishment (t/ha)	**1.304**	**-**	**-**	**-**	**-**	**-**
% of the rate	1.2	-	-	-	-	-
Period 2 –development(t/ha)	**2.024**	**0.008**	**0.025**	**-**	**-**	**-**
% of the rate	1.8	0.1	0.2	-	-	-
Period 3 – maturing (t/ha)	**73.10**	**0.64**	**0.10**	**0.20**	**0.32**	**0.27**
% of the rate	66.4	1.6	1.0	4.0	6.0	9.4
Period 4 – residue (t/ha)	**1.26**	**0.02**	**0.002**	**-**	**0.015**	**0.024**
% of the rate	1.1	0.1	0.1	-	0.3	1.0
Rate of erosion (t/ha)						
November 95-October 96	**110.14**	**38.18**	**13.53**	**5.35**	**5.26**	**2.90**

It is obvious that the convincingly greatest rate of erosion (146.32 and 110.14 t/ha) was recorded in the unsown - standard trial variant. This quantity is several times higher than the tolerant level of erosion – T value, which for this type of soil amounts to 10 t/ha/y [3] and [25], This is followed by the variant involving conventional ploughing up/down the slope with 38.53 and 38.18 t/ha, respectively, of eroded soil. A smaller rate of erosion was recorded in the no-tillage variant (22.86 and 13.54 t/ha) and in very deep ploughing across the slope (21.12 and 5.26 t/ha, respectively). This is followed by conventional ploughing across the slope with the rate of erosion of 11.6 and 5.35 t/ha, respectively. The best results in terms of soil conservation were achieved in the variant involving subsoiling with ploughing across the slope, where erosion rates were only 2.99 and 2.9 t/ha, respectively. The results give absolute advantage to ploughing across the slope. Up/down the slope ploughing should be omitted altogether. Maize and soybean are considered to be "high-risk crops" by all the authors studying erosion problems on arable areas, regardless of the tillage direction [2], [4], [10], [12], [13] and [16]. Besides, in early sowing, at a time when the soil is bare and unprotected, of spring row crops, as crops of low density, the large intra- and inter-row spacing enables intensified erosion. Therefore, soil under row crops cannot be fully protected from the direct impact of raindrops even in later stages, which leads to erosion also in later crop-stages. Application of ploughing across the slope may reduce erosion to a tolerant level by comparison with the up/down the slope ploughing and sowing. The position of furrows in this tillage practice prevents excessive surface runoff and thus reduces erosion. In the treatments with deep tillage, the larger depth of the plough-layer enables stronger infiltration of water and in this way additionally reduces surface runoff.

The results show that the critical period in growing row (spring) crops is that of bare soil, the SB period. On the standard plot according to USLE, an erosion rate of 23.7% (maize) or 29.4% (soybean) was recorded in that period. Different results were obtained in other variants. In ploughing up/down the slope, the SB period erosion accounted for 74.9 and 98.0%, respectively, of the total annual erosion while in the no-tillage variant it amounted to 80.8 and 98.6%, respectively. In the variant involving ploughing across the slope, the SB period erosion amounted to 81.8 (maize) and 95.7% (soybean) of the annual rate of erosion while in the variant with very deep ploughing across the slope to 88.9 and 93.2%, respectively. In the variant of subsoiling with ploughing across the slope, the SB period erosion accounted for 90.0 and 87.4%, respectively, of the annual rate. The reason for such high values is that this is the period when the soil is bare and unprotected - without any vegetational cover, immediately after sowing. Raindrops of high intensity fall directly onto the soil, which leads to surface runoff and occurrence of erosion in all trial variants.

3.3.2. Erosion in the growing of winter crops

Winter crops were grown in the last two years (wheat in 1996/97 and oil seed rape in 1997/98). Soil erosion in those years was determined per different stages of crop development according to USLE and is shown in Table 6.

Like in the growing of row crops, the highest rate of erosion was recorded in the standard variant. In

winter wheat growing erosion amounted to 86.77 t/ha and in oil seed rape to 54.05 t/ha. Although erosion rates were lower than in the first two trial years, this is still very high erosion, which exceeds the tolerant threshold of soil loss (T value) of 10 t/ha/y for this soil type. Rates of erosion recorded in all the other treatments were below the tolerant soil loss. As expected, relatively higher rates were achieved with ploughing up/down the slope. In this variant, erosional drift amounted to 0.54 t/ha in winter wheat and to 0.40 t/ha in oil rape. The total annual soil loss in the no-tillage variant amounted to 0.22 t/ha (wheat) and 0.34 t/ha (oil seed rape) while in the variant with ploughing across the slope it was 0.07 and 0.13 t/ha, respectively. In the variant with very deep ploughing across the slope, erosion was 0.31 and 0.17 t/ha, respectively. The lowest rates of erosion and the highest efficiency of soil protection were recorded in the variant involving subsoiling and ploughing across the slope. The rates in this variant amounted to 0.13 t/ha and 0.08 t/ha of eroded soil.

Table 6. Soil erosion in different crop-stages and the rate of erosion in growing winter crops

Crop-stage	Standard plot (black fallow)	Ploughing up/down the slope	No-tillage	Ploughing	Very deep ploughing across the slope	Subsoiling +ploughing across the slope
WINTER WHEAT GROWING						
Seedbed (t/ha)	12.22	0.226	0.03	0.027	0.172	0.102
% of the rate	14.1	41.9	13.6	36.2	56.3	77.0
Period 1 – establishment (t/ha)	9.112	0.213	0.064	0.002	-	0.018
% of the rate	10.5	39.4	28.7	2.5	-	13.8
Period 2 – development (t/ha)	3.946	0.025	0.023	0.008	-	-
% of the rate	4.5	4.6	10.2	11.5	-	-
Period 3 – maturing (t/ha)	52.54	0.07	0.08	0.035	0.10	0.01
% of the rate	60.6	12.9	38.4	46.6	33.2	7.7
Period 4 – residue (t/ha)	8.94	0.006	0.02	0.002	0.032	0.002
% of the rate	10.3	1.2	9.1	3.2	10.5	1.5
Rate of erosion, (t/ha) October 1996-August 1997	**86.77**	**0.54**	**0.22**	**0.07**	**0.31**	**0.13**
OIL SEED RAPE GROWING						
Period F - rough fallow (t/ha)	0.633	0.002	0.284	0.007	0.112	0.001
% of the rate	1.2	0.5	83.9	5.5	64.0	1.2
Period SB – seedbed (t/ha)	0.007	0.007	0.002	0.002	-	-
% of the rate	0.1	1.7	0.7	1.3	-	-
Period 1– establishment (t/ha)	30.453	0.319	0.020	0.092	0.037	0.042
% of the rate	56.3	80.2	5.9	72.1	21.1	52.2
Period 2 – development (t/ha)	16.533	0.052	0.015	0.027	0.026	0.038
% of the rate	30.6	13.1	4.3	21.1	14.9	46.6
Period 3 – maturing (t/ha)	2.179	0.014	0.015	-	-	-
% of the rate	4.0	3.6	4.5	-	-	-
Period 4 – residue (t/ha)	4.251	0.003	0.002	-	-	-
% of total drift	7.8	0.9	0.7	-	-	-
Rate of erosion, (t/ha) August 1997-July 1998	**54.05**	**0.40**	**0.34**	**0.13**	**0.17**	**0.08**

Accordingly, regardless of the ploughing direction, erosional drifts in the growing of winter crops were much lower than in the first two trial years when row crops were grown. This is the reason why, in soil conservation, we lay greater importance on the crop grown than on the tillage method applied. In the next few sentences, we will try to answer the question why erosion rates were much lower in the growing of winter crops.

Winter crops were sown towards the end of October (winter wheat) and August (oil seed rape). Sowing was preceded by a long and dry summer period, during which rather coarse structure aggregates, which increase the intensity of rainwater infiltration and reduce or prevent surface runoff, were formed. Besides, there are usually no high intensity rains after wheat and oil rape sowing, rain falls onto dry soil and the soil can take up large quantities of water for saturation to field capacity. No surface runoff occurs in such conditions. In the winter period of the year when the soil is fully saturated and if it does not get frozen, erosion does occur but the drift quantity is small.

In the growing of winter crops there are no critical periods with occurrence of large quantities of erosional drift. Data from Table 6 show a uniform distribution of erosion during the whole growing season of winter crops. In the period of the highest erosion risk in the studied area (May-June), winter crops fully cover soil surface with a dense cover. This vegetational cover efficiently protects the soil from the direct impact of raindrops (which are often very intensive in this part of the year) and thus contributes to the reduction of the erosion rate.

In the foregoing text, soil losses were presented per particular crops. It can be seen that low-density row (spring) crops are subjected to high erosion in the variant involving ploughing and sowing up/down the slope, whereas erosion rates are much smaller in treatments involving ploughing across the slope. Much lower erosion was recorded in the growing of high-density winter crops regardless of the

ploughing direction. These results are in agreement with the results obtained by other authors: [7], [8], [11], [18], [21] and [29].

3. Conclusions

The presented results show that water erosion cannot be completely stopped, however it can be reduced to a tolerant level by choosing appropriate tillage treatments.

Appreciably higher rates of soil erosion were recorded in the growing of low-density row (spring) crops (maize and soybean) than in high-density winter crops (wheat and oil seed rape) under the same tillage treatments. The time immediately following the sowing of spring crops (SB-seedbed) is the most critical period, that is, the period when highest soil erosion occurs.

Growing of row (spring) crops, which dominate the crop rotation in the investigated area, on sloping terrains will require a balanced tillage system (no-tillage and ploughing across the slope) and an appropriate crop sequence.

Efficient soil conservation on Luvic stagnosol of 9% and milder slopes can be achieved by no-tillage and all across-the-slope tillage practices. Summing up all the advantages and drawbacks of the studied tillage practices for a wide application in crop growing on this soil type, we recommend no-tillage and conventional ploughing across the slope.

References

1. Abebe, A., 1992. Assessment of runoff and soil losses under different cover crops and slop lengths. Inst. of Agr. Res., Addis Ababa, Ethiopia, 50-56.
1. Bašić, F., I. Kisić, A. Butorac, and M. Mesić. 1997. Soil erosion by different tillage systems on stagnosol in Croatia, Proceedings of the 14th Conf. of ISTRO, Pulawy, Poland, 63-67.
3. Bašić, F., 1992. Bodenerosion in Rahmen des Bodendauerbeobachtungsflachen - programms, Exp. der gemeinsamen Arbeitsgruppe für Bodenschutz, ARGE Alpen, Alpen-Adria und Donauländer, “Bodenerosion und Strukturveränderung”, Bayerisches Staatsministerium für Landesentw. und Umweltfragen, Zagreb, Croatia, pp. 57-76.
4. Bašić, F., I. Šalinović, I. Bašić, A. Kellkayyelah, and A. Butorac, A. 1991. Possibilities of Soil Conservation by Means of Different Tillage Systems on Acric Ferralsol of the Ethiopian Plateau. Proceedings of the 12th Conference of ISTRO: Soil Tillage and Agricultural Sustainability, Ibadan-Nigeria, 58-60.
5. Bašić, F., Butorac, A., Mesić, M., Sabolić, M. 1993a. Aktualna pitanja erozije i smjernice konzervacije oraničnih tala Hrvatske, Polj. aktualnosti 3-4, pp. 227-249.

6. Bašić, F., Butorac, A., Šalinović, I., Bašić, I., 1993b. Agroecological Study of Horo Alleltu Farmland, Proposal for Preliminary Project of Integral Soil Conservation-Guidelines for Conservation Farming System, final revised version, Nekemte - Agroindustrial Project, Ministry of State Farms, Coffee and Tea Development-North Western Agricultural Development Corporation, Addis Ababa-Ethiopia, p. 258.
7. Chisci, G., V. Boschi, 1988. Runoff and Erosion Control with Hill Farming in the Sub-coastal Apennines Climate. Soil and Tillage Research, 12/105-120.
8. Dean, J.E., 1996. Use of hordeum pusillum nut (Little Barley) native cover crop in long-term conservation tillage systems. J. Soil and Water Conserv. 41/4, 359-366.
9. Derpsh, R., C.H. Roth, N. Sidiras, and M. Köpke. 1988. Erosionsbekämpfung in Parana Brasil: Mulchsysteme, Direktsaat und konservierende Trodenbearbeitung, Schrift. der Deutschen Gesell. für Techn. Zusammenarbeit, Eschborn, p. 270.
10. Gil, E. 1990. Rational land use on slopes from the point of view of flood and erosion protection. Problemy Zagospodorovania Ziem Gorskich, Poland, p. 31-48.
11. Jasa, P.J., and E.C. Dickey. 1991. Subsoiling, contouring, and tillage effects on erosion and runoff. Applied engineering in agriculture, University of Nebraska, USA, p. 80-85.
12. Jung, P.K., M.H. Ko, and K.T. Um. 1985. Discussion of cropping management factor for estimating soil loss. J. Korean Soc. Soil Sci. and Fertilizer, Suwon Korea, p. 7-15.
1. Kisić, I., F. Bašić, A. Butorac, and M. Mesić. 1998. Soil erosion in different tillage systems on stagnosol in Croatia. Proceedings of the 16th World Congress of Soil Science, Montpellier, France.
14. Klik, A., F. Fila, N. Spatny, J. Rosner, and O.W. Baumer. 1996. On-Site and Off-Site Effects of Different Tillage Systems under Austrian Farming Conditions. International Annual Meeting ASAE, Phoenix, Arizona.
15. Laflen, J.M., J.L. Baker, R.O. Hartwig, W.F. Buchele, and H.P. Johnson. 1978. Soil and water loss from conservation tillage systems. Trans. ASAE 21, 881-885.
16. Laflen, J.M., and W.C. Moldenhauer. 1979. Soil and Water Losses from Corn-Soybean Rotations. Soil Sci. Soc. Am. J. 43, 1213-1216.
17. Lal, R., 1976. No-tillage effects on soil properties under different crops in western Nigeria. Soil Sci. Soc. Am. J. 40, 762-768.
18. Malone, R.W., R.C. Warner. 1996. Runoff losses of water, soil and surface applied metribuzin as influenced by yard waste compost amendments, no-tillage and conventional tillage systems. J. Soil and Water Conserv. 41/4, 365.
19. Meyers, J.L., and M.G. Wagger. 1996. Runoff and sediment loss from three tillage systems under simulated rainfall. Soil and Tillage Research, No. 39/115-129.

20. Oh, S.J., P.K. Jung, M.H. Koh, and T.S. Kih. 1989. Aspects of soil erosion with different clay contents and slope gradients under simulated rainfall. The Research Reports of the Rural Development Administration, Soil and Fertilizer, p. 29-41, Korea.
21. Rejman, J., 1995. Assessment of erosion risk on loess soil. From Soil Survey to Sustainable Farming. Proceedings of Conf. at the 35th Anniversary of the Institute, organized within the ENCY activities, High Tatras, Stara Lesna. p. 343-347.
22. Rejman, J., 1997. Runoff and Soil Loss under Conventional Tillage for Cereal Production in SE Poland. Proceedings of the 14th Conf. of ISTRO, Pulawy, Poland, 559-563.
23. Schultz, J.E., and D.K. Malinda. 1994. Rotation, tillage and residue management effects on rainfall infiltration and soil erosion. Proceedings of the 13th Conference of ISTRO, Aalborg Denmark, p. 353-358.
24. Sibbesen, E., P. Schjonning, A.C. Hansen, J.D. Nielsen, and T. Heidmann. 1994. Surface runoff, erosion and loss of phosphorus relative to soil physical as influenced by tillage and cropping systems. Pro. of the 13th Conf. of ISTRO, Aalborg Denmark, p. 245-250.
25. Schwertmann, U., W. Vogl, and M. Kainz. 1987. Bodenerosion durch Wasser. Vorhersage des Abtrags und Bewertung von Gegenmaßnahmen. Stutgart, p. 86.
26. Šalinović I., Bašić I., Bašić F., Kellkayelah A., Butorac A. (1989). Prediction of Soil Erosion Using USLE in Horo Alleltu Area in Ethiopia. 12th ISTRO Conference. Ibadan. Nigeria. pp. 48-49.
27. Šalinović I. (1997). Procjena erozije tla vodom na važnijim feralitičnim tlima u provinciji Wolega - Etiopija. Magistarski rad. Zagreb, str. 85.
28. Wischmeier, W.H., 1960. Cropping-management factor for a Universal Soil Loss Equation. Soil Science Society Proceedings, pp. 322-326.
29. Wischmeier, W.H., 1973. Conservation tillage to control water erosion. Conservation tillage, Soil Conservation Society of America, 133-141.
30. Wischmeier, W.H., and D.D. Smith. 1978. A Universal soil-loss equation to guide conservation farm planning. In Int. Congr. Soil Sci.,Trans.,7 Int.Soc.Soil Sci., Madison, 418-425.
31. *** 1994. World Reference Base for Soil Resources, ISSS, ISRIC, FAO, Wageningen/Rome.

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SMALL BUSINESSES IN SOUTH AND WESTERN HUNGARY IN THE NINETIES - RESULTS OF A SOCIOLOGICAL SURVEY

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ABSTRACT

The objectives of the research are to analyse the main features of small businesses of South and West Hungary, to identify the main tendencies of their operation and development and to determine the main motivating factors in their business management processes. The area under examination covers rural county Zala, rural county Somogy, and the settlements located by the Western shore of lake Balaton. The main findings: the fast increase in the number of the small and medium size enterprises is due to the loss of the employment possibilities, the inclination and resources of vocationally trained workers to establish their own businesses including family traditions, the desire to achieve tax reduction and income maximisation, and higher incomes. Difficulties are caused by the lack of available capital. Enterprises not turning back part of their gains into the business cannot provide sufficient income for the family.

KEYWORDS: small enterprise, capital resource, human resource, South-West Hungary

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DETAILED ABSTRACT

The objectives of the research are to analyse the main features of small businesses working in South and West Hungary, to identify the main tendencies of their operation and development being either similar to, or different from the national averages in Hungary, and to determine the main motivating factors in their business management processes. The area under examination covers three areas: rural county Zala, rural county Somogy, and the settlements located by the Western shore of lake Balaton, within which, the two towns Keszthely and Héviz were analysed separately from the other villages.

The fast increase in the past decade in the number of the small and medium size enterprises may be the overall result of several factors. The first contributing factor is the loss of the employment possibilities provided by the state, the growing uncertainty about jobs. On the other hand, formerly employed workers with various vocations, having solid professional experience, sufficient financial resources, marketable knowledge and skills, ready to make initiatives and take risks, decided to establish their own businesses and became private entrepreneurs. The second reason may be the desire to achieve tax reduction and income maximisation legally possible within an enterprise. The third factor is the desire to maintain or increase the former living standards. An enterprise may offer wider opportunities for higher or additional incomes, and it is often the only available income source. The enterprises capable of providing sufficient income for the entrepreneur for a decent standard of living are those, which turn back part of their gains into the business itself. The majority of the private entrepreneurs using up their business savings in the household - for consumer goods or home equipment - cannot rely entirely on the entreprise as the only income source. The resulting living standard is the highest for the entrepreneurs separating their business and household finances.

1. INTRODUCTION

The objectives of the research are to analyse the main features of small businesses working in the small towns and villages of South and West Hungary, to identify the main tendencies of their operation and development being either similar to, or different from the national averages in Hungary, and to determine the main motivating factors in their business management processes. Similar research results were published in the early 1990's *(Czakó et al., 1995; Czakó, 1997; Gábor, 1994*). The present study focuses on the main features and tendencies of the situation at the end of the 90's in West and South Hungary. The area under examination comprises three sub-regions: rural county Zala, rural county Somogy, and the settlements located by the lake shore, in the Western basin of lake Balaton. Within the latter, the two towns Keszthely and Héviz were analysed separately from the other villages.

2. MATERIALS AND METHODS

The remarkable increase in the number of the small and medium size enterprises is considered an important feature of the Hungarian social and economic transformation process, by the social scientists and economists. (Within the Hungarian national economic accounts the expression "sole proprietorship" is used for retail shops, small scale manufacturers, private intellectuals, professionals who are self employed. Partnerships are - in agreement with the international usage - the small business organisations having legal entity. When small and medium size enterprises are mentioned in this paper, the term refers to the sole proprietorships and the partnerships working with not more than 50 employees.)

In the second half of the 90's the number of the small and medium size enterprises in Hungary was approximately 1 million. Their structure is uneven, disproportionate, the majority of them are micro-businesses, that is, family enterprises of 2-3 persons. Some researchers *(Kovách, 1995; Szelényi, 1990)* say, that to establish a market economy in Hungary the increase in the number of private businesses and the enlargement of the so-called middle class is necessary. According to the above researchers the future members of this middle class would be the present private entrepreneurs ad small business owners. Others question the above statements, and relying on the fast increase in the number of the enterprises, and on their social stratification, doubt that they are all really entrepreneurs in the true economic meaning of the word.

In the present research approximately 300 entrepreneurs living in the researched area were surveyed about the main characteristics of their business and life style. The survey was focused on the process already researched in the early 90's, but more clearly visible since the relatively long time that had elapsed since the beginning of the social and economic transition of the country. The main research problems the entrepreneurs were quesioned about are the following:

What is the main aim of their businesses? Is it the efficient operation of the capital and the generation of profits, or the subsistence of their families and the maintenance of the consumption level they wish to achieve? How can they achieve their aims? Do they sell their working capabilities, or do they utilise it themselves in a family enterprise?

The main issue may be summarised in the following way: are the owners of the small and medium size businesses, as economic agents, considered to be entrepreneurs, small scale producers, or self employed persons finding no other possible way to earn their living?

The following questions were asked in the questionnaire:

- Who are the entrepreneurs and why do they manage an enterprise?
- What are their ages and school background?
- What material, human, personal and professional resources do they have?
- What fields of activities are their businesses involved in?
- Is the enterprise a main, or a secondary (additional) source of income?
- Are the family traditions important in starting one's own business?
- Are there differences within the generations, and according to the ages of the entrepreneurs?
- What are the main reasons for the fast increase in the number of the enterprises?

General features of the researched area

The research was focused on counties Zala and Somogy, and within them two towns in Zala, and several small villages of the counties were analysed. Within Zala the two towns Keszthely and Héviz vere analysed separately from the villages, and another separate group was formed from the villages located around lake Balaton (in the tables and figures these villages are referred to under the heading "Balaton"). The other villages in Zala and in Somogy are grouped under the respective names "Zala" and "Somogy". County Zala, being the centre of the researched area, has the following characteristics:

- the population density is lower, and the mortality rate is higher than the national average;
- the decrease of the population is smaller, and the proportion of the 18-39 year old inhabitants is higher than the national average;
- the proportion of the industrial employees is less than the average, the proportion of the employees working in the service sector is the same as in Budapest, the capital;
- less than average unemployment rate, especially for the long time unemployed;
- the paid personal income tax per inhabitant is less than the national average;
- high number of the registered enterprises;
- above average proportion of the industrial factories closed down since 1990;
- high number of shops and catering businesses.

(Csite, 2000)

The area has a stable population, developed entrepreneurial mentality and outstanding capacities for tourism. The larger part of the population lives in above average financial and material conditions. A seemingly contradictory fact may be the less than average level of personal income tax paid, and the less than average level of income per person. However, there are strong indications that a large part of the incomes generated by the tourism industry is never mentioned in the taxation accounts (the tax accounts register mainly the incomes of employees, and a significant proportion of the incomes generated by private activities is actually hidden from the taxation authorities). The importance of tourism is indicated by the fact that in 1997 Keszthely had 30 catering businesses, restaurants, pubs, bars, while the neighbouring Héviz had 18, 4 travel agencies operated in Keszthely, and 2 in Héviz, 36 hotels and guest houses offered accommodation for the tourists in Keszthely and 52 in Héviz, and these numbers have not decreased since. The majority of the accommodation is run by families as private enterprises, who had had rooms to let even before 1990, when they offered accommodation mainly for German and Austrian tourists.

It is clear from the earlier research results that a significant proportion of the small scale entrepreneurs is a so-called "forced entrepreneur" *(Matolcsy, Diczházi, 1998)* and these people would immediately give up their enterprises if they found a job with secure earnings. Their enterprises can generate only a moderate level of income and the main reason for starting the enterprise was the lack of other means for the survival of the person and the family.

The research by *Czakó et al. (1995),* aimed at describing the typical characteristics of the small businesses in 1993 stated, that though officially 790 000 enterprises with less than 50 employees are registered in Hungary (agricultural enterprises not included), not all of them actually operated. According to their estimations the number of the real running businesses was approximately 20 % less than the number of registered businesses. Since then important steps were made by the authorities to close down the non-existing "phantom" enterprises, so their proportion has been probably decreased, also due to the changed legislation about the social security charges to be paid by enterprises. Another finding of the mentioned research was that 4 - 5 % of the interviewed businesses said to have had no income in 1992 at all.

The social structure of the group of enterpreneurs has undergone significant changes since 1988. In the 80's the notion of being an entrepreneur had become increasingly attractive, but due to economic and political reasons the possibilities for becoming a private entrepreneur were rather restricted, and a strong selection mechanism was visible. To become an entrepreneur the person had to have above average social, cultural and personal connections. Disadvantaged positions were equally typical in the job market for women, people with low schooling, people in unfavourable job positions, the elderly, and low paid young people. Besides the traditional craftsman and retail shopkeeper, partnerships emerged in the middle of the 80's with founders and owners being middle age men, better educated than the average population.

From the early 90's people of various social backgrounds had entered the business sector as entrepreneurs, when the legal conditions had been established, and the political risk associated with a private business disappeared. At the same time, with the increasing unemployment rate, for many people the only available way of earning a living became the establishment of a small scale enterprise.

The idea of the private enterprise had become the symbol of free economy and high living standards within reach, but the negative experiences soon discarded this illusion. The public opinion about the enterprises also changed. In 1990 40 % of the adult population expressed their willingness to become, or satisfaction in being an enterpreneur, this proportion is only 20 % in 1993, 24 % in 1994. The decrease is due to the changed opinion of the professionals and the unskilled, while the skilled workers have continuously found the position of the private small scale entrepreneur attractive (Czakó et al, 1995).

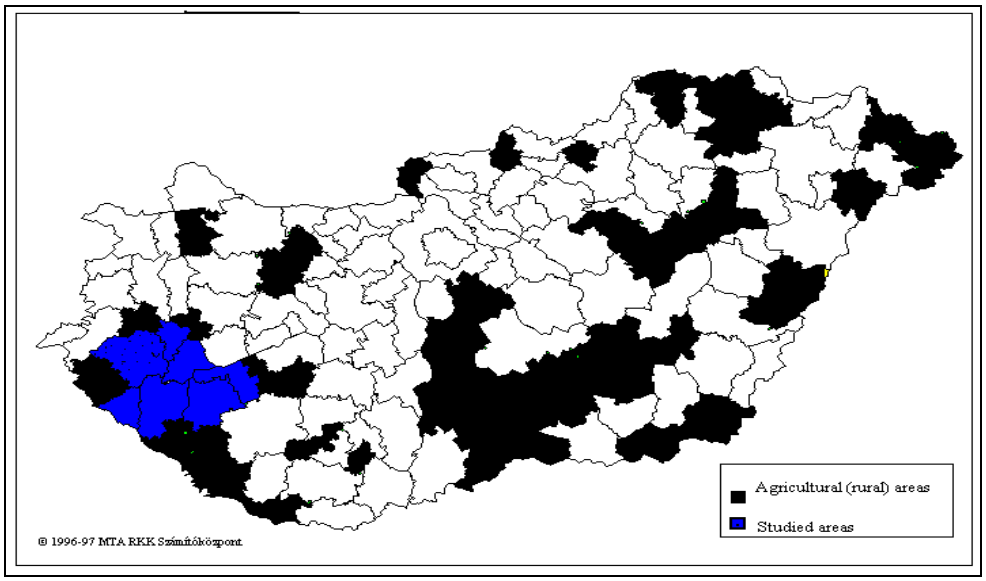
In our research the main objectives were to identify the demographic and sociological characteristics of the small scale entrepreneurs as well as the means and resources they can use to carry out the business activities, the level of their profits or losses, the proportion of their profits they can accumulate, and the purpose they use these savings for. Another issue was whether regional differences can be identified.

3. RESULTS

Social characteristics and motivating factors of the entrepreneurs

The analysed agricultural and non-agricultural small and medium size enterprises working South and West Hungary can be grouped into two distinct categories. The villages within the triangle defined by the villages Zákány, Somogyvár and Zalaszentgrót have lost their economic value. However, at the same time in the sub-region of Keszthely and Héviz dynamic progress has started, due to the natural resources of the area (lake Balaton, thermal lake of Héviz). Within this sub-region the dominant force of development is not the in-flow of foreign capital and multinational companies, but the small and medium size businesses owned by Hungarian entrepreneurs. This is an outstanding and exceptional model of development in Hungary.

Figure 1: Agricultural areas in Hungary and the researched area *(Legends: Black: agricultural zones in Hungary, Grey: studied area in present research)*



The researched settlements may be grouped into the following categories by their position after the transition in the 90's:

- *Small villages* - whose strategic aim is survival, fighting for their pure existence.
- *Villages and small and medium size settlements* -with somewhat better positions than that of the small villages, but not much.
- *Large villages and settlements* - having specific advantages due to touristic attractions and resources, thus they can join the winners of the social and economic transition of the country.
- *Small agricultural towns* - facing losses in the global competition but having strategic plans for development.
- *Towns (as Keszthely and Héviz)* - being in clearly advantageous position, although some (as Keszthely) have financial difficulties. These difficulties are mainly due to the disproportionately large tasks (large number of schools up to 1999, maintenance of a hospital) for which the state budgetary support is insufficient. Several expanding small businesses exist, concentration of capital is in progress, and Keszthely, in particular, has a strong chance to develop into a commercial, touristic and cultural centre in the region.
- *Large towns, cities* - they belong to the winners of the transition process towards market economy, though none of the settlements we investigated belong into this category.A few Hungarian-owned large corporations are located in these towns and cities, with good opportunities for regional expansion in the Carpathian basin. Such towns and cities, with transnational development opportunities to become regional centres are Debrecen, Pécs, Szeged, and Győr in Hungary.
- *Budapest, the capital* - which is on the top of the settlement hierarchy, being not only a large city but the main winner of globalisation, of the transition toward the market economy and of the original capital accumulation and reallocation process.

A considerable capital concentration process can be identified the 90's in accordance with the settlement hierarchy described above. While the winners become concentrated, the losers, though with significant clustering, are geographically spread, and are scattered in sectors and industries, and differ greatly by their sizes and settlement types, both in economic and social terms. A typical feature of the Hungarian economy is the growing importance of the younger generation in the leading positions of management, as well as the increasing number of female leaders (more women have leading positions in businesses that before, though their proportion has still been low).

The proportion of female entrepreneurs has also grown, which may be partly due to the fact that the number of businesses involved in sales and retail activities has rocketed. Retail is often a family business, as is underlined by our research, and it is equally possible and probable for the wife and the husband to be the registered owner of the family entreprise.

3.1 The reasons for starting the enterprise

According to our survey the main reasons of starting and running an enterprise are summarised in the following two tables.

Table 1: How do you carry out your business activity?

	Balaton	Keszthely	Héviz	Zala	Somogy	Total
Full time , %	90.91	74.68	76.00	61.18	39.47	62.72
Part time, %	4.55	12.66	16.00	22.35	28.95	19.51
Retired, as pensioner, %	4.55	2.53	4.00	10.59	17.11	9.06

Table 2: Why did you start your own enterprise?

	Balaton	Keszthely	Héviz	Zala	Somogy
Loss of former job, %	4.55	12.66	8.00	15.29	13.16
Hope for larger income, %	45.45	36.71	44.00	29.41	30.26
Entrepreneurial mentality,%	36.36	18.99	28.00	16.47	30.26
Family traditions,%	9.09	11.39	8.00	12.94	18.42
No other source of income,%	31.82	32.91	24.00	32.94	17.11

A significant difference may be identified between the towns of the area (Keszthely and Héviz) and the villages around lake Balaton, and the small settlements in county Zala and county Somogy. Note, that the total percentages being higher than 100 % mean that more than one reasons were allowed for each respondent to choose.

The loss of the former job has a high share among the reasons in Keszthely, Zala and Somogy, but the "No other source of income" reason also indicates limited job opportunities in the area. The importance of these two reasons together represent nearly 45 % in Zala and Keszthely, while they add up to approximately 30-35 % in the other three settlement groups. These figures underline the fact that the close down of industrial factories in Zala and in Keszthely greatly contributed to the fast increase in the number of the "forced" entrepreneurs. The proportion of enterprises run in full time is high, its share is above 60 % except for Somogy. The 17 % proportion of retired entrepreneurs in Somogy indicates that the former agricultural employees do not receive sufficient pension to maintain a moderate living

standard, so the low amounts of agricultural pensions also compel the retired agricultural population to carry out some income generating entrepreneurial activity.

The breakup of industrial corporations offered opportunities for the entrepreneurs in the commercial, trade and services sectors. The services sector actually enjoyed the advantages of increased demand due to the prosperity in the 80's and the entrance of foreign purchasers in the real estate business.

The hope of higher income as a motivating factor represents a high share in each settlement group, as the entrepreneurs choose the risky option of establishing their own private enterprise to substitute it for the former earnings gained from second jobs typical of the former decade. This is particularly clear in the settlements around lake Balaton, and in the two towns, which are basically resort areas, and where the entrepreneurs may hope for higher incomes coming from the tourism industry and the supporting services activities.

3.2 How do the entrepreneurs spend their savings?

Assessing the responses received for the above question we may conclude, that the majority of the entrepreneurs do not strictly separate the household spendings and the entreprise spendings, and the same is true for the incomes. The proportion of enterprises with no capacity to save from the generated incomes is also very high, it is about 15-17 % except for Zala (see table below).

Table 3: How do you spend the savings of the enterprise? (% share)

	Balaton	*Keszthely*	*Héviz*	*Zala*	*Somogy*	*Total*
Turn back to the entreprise, %	50.00	24.05	38.46	18.82	14.47	23.26
Use it in the household, %	36.36	20.25	26.92	22.35	28.95	25.00
Both of the above two, %	22.73	37.97	34.62	52.94	40.79	41.67
Buy only bonds and shares, %	4.55	0.00	0.00	3.53	0.00	1.39
No savings are generated, %	18.18	15.19	15.38	8.24	19.74	14.58

3.3 Has new capital been invested in the enterprise?

The following table shows the proportion of the various sources in the capital assets of the enterprises.

Table 4: Percentage share of the resources of capital invested

	Balaton	*Keszthely*	*Héviz*	*Zala*	*Somogy*	*Total*
Banks	9.09	11.39	8.00	8.24	7.89	9.06
Credits with state support	0.00	3.80	0.00	1.18	1.32	1.74
Friends, relatives, family	13.64	25.32	32.00	8.24	13.16	16.72

Entrance of new partner with capital	4.55	3.80	4.00	1.18	0.00	2.09
Sale of family property	9.09	6.33	12.00	4.71	3.95	5.92
Other	4.55	1.27	0.00	1.18	2.63	1.74
No capital invested	45.45	58.23	48.00	64.71	55.26	57.49

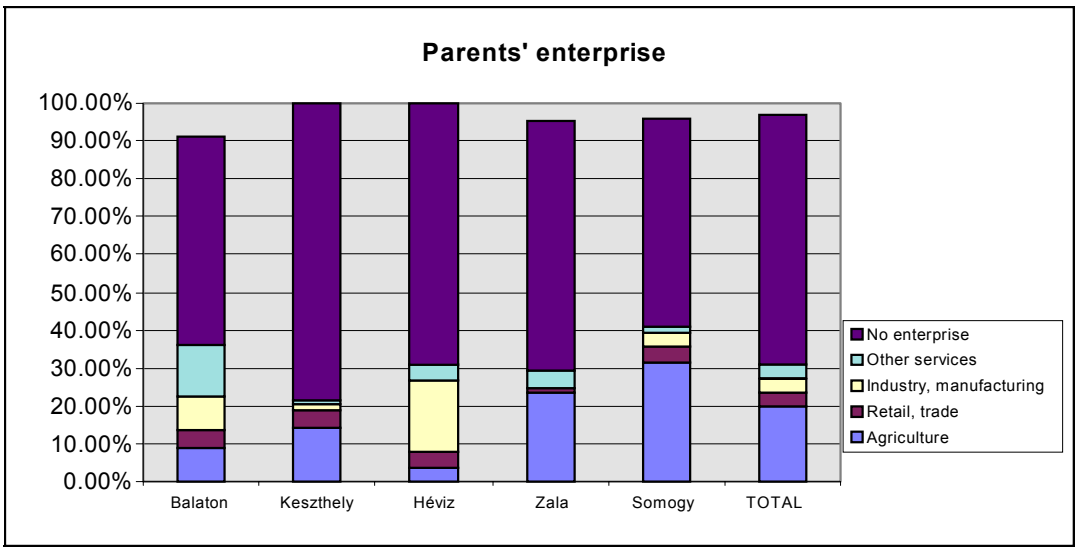
The above figures show that the majority of entrepreneurs can hardly have any access to credits. The proportion of bank credits is slightly more than 10 % in Keszthely, and much lower elsewhere. The share of the sale of family property, and the resources of friends and relatives is as high as that, or even higher. About half of the entreprises cannot attract extra capital at all (45 -64 %). This means that the capital needed to start, or expand the entreprise comes mainly from the household savings of the family, relatives and friends.

3.4 Intellectual and human resources, professional knowledge and skills

In starting a new enterprise the knowledge, skills and personal connections gained in the former employment are of great importance. Another important factors are the entrepreneurial tradition and the help in raising the starting capital, all of which often come from parents and grandparents. Besides these the preferred values, lifestyle patterns, cultural background also play an important role. According to the opinion expressed by *Kovách (1997)* the children and grandchildren of well-to-do and rich peasants inherited the inclination towards private enterprise, risk taking, wish for independence, and these people are the private small scale farmers who had carried out private farming as early as the 60's and 70's in greater scale than the household plots.

In our survey the entrepreneurs were asked whether their parents and grandparents had been entrepreneurs themselves (see figure 2).
The responses show that 30 % of the grandparents were farmers themselves, while only 20 % of the parents had an agricultural entreprise. The difference is partly due to the fact that before Wold War II the proportion of agricultural population had been much higher within the total population of the country. In the villages of Somogy the proportion of farmer grandparents is even higher (36%), while in Héviz and the settlements around Lake Balaton this proportion is lower (Balaton: 28%, Héviz: 19%). At the same time higher proportion of the grandparents had been craftsmen around lake Balaton (10%), Keszthely and Héviz (4-4 %), than the average proportion for the total respondents (2 %).
Even more striking is the proportion of grandparents with retail shops in the Balaton area and Héviz, here again the proportion is approximately 10% while the average for all respondents is only 2 %.

Figure 2: The area of entrepreneurial activity of the parents of the entrepreneurs (%)



In assessing the parents' entreprises again agricultural entreprises represent the highest proportion, though their share is less than for the grandparents. However, in Héviz only 5 % of the parents had been agricultural entrepreneurs, and the values in the Balaton villages (8 %) and in Keszthely (12 %) are still below the average. The proportion of parents having agricultural entreprises is highest in the Somogy settlements (above 30 %).

These results cleary show that the parents and grandparents living in rural settlements had run agricultural enterprises, while the parents and grandparents living around lake Balaton were mainly involved in manufacturing and retails activities (see e.g. the 20 % proportion of craftsmen among the parents of the Héviz entrepreneurs). This underlines the statement, that the example of parents and grandparents running their own enterprises has had a significant role in the choice of their children to become private entrepreneurs themselves.

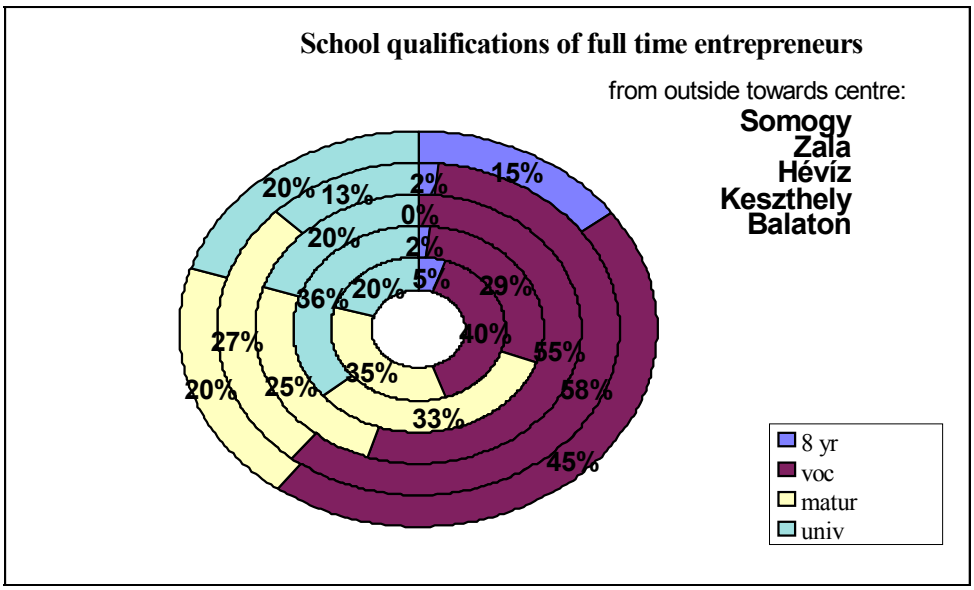
The majority of the entrepreneurs had had higher school qualifications according to the surveys done in 1988 and 1993 *(Czakó et al., 1995).* In 1988 8 % of the entrepreneurs had the 8 year elementary school leaving certificate as highest qualification, in 1993 this proportion is 7 %, while in our survey this

proportion is still lower, except for Somogy where it is 9%, 2 % in Zala, 0 % in Héviz, 2 % in Keszthely and 5 % in the Balaton settlements.

It may be assumed that the reason for the relatively high 9 % proportion of Somogy is that the majority of the entrepreneurs are farmers here, the level of education in agricultural settlements is usually lower than in towns, and the businesses run in towns usually require higher vocational skills and qualifications.

In 1988 the proportion of entrepreneurs with vocational secondary school qualitifications was 26 %, and in 1993 30 %, while our survey shows further increase. The proportion is 45 % in Somogy, 58 % in Zala, 55 % in Héviz, 40 % in the Balaton settlements and 28 % in Keszthely. The proportion of entrepreneurs with college or university degrees is an outstanding 36 % in the five settlement groups analysed, while the proportion with maturation certifications is 33 %.

Figure 3: School qualifications of the full time entrepreneurs (Legends: *8yr*: completion of 8 year elementary school only; *voc:* vocational school; *matur*: completion of secondary school with maturation certification; *univ:* college or university degree)



The proportion of the full time entrepreneurs with maturation certifications differs for the two former surveys and our survey. In 1988 this proportion is 44 %, in 1993 it is 41 %, while our survey shows,

that in Keszthely 33 %, in the Balaton settlements 35 %, in Somogy only 20 % of the entrepreneurs has maturation certifications as the highest school qualification (see Figure 3).

As a summary we may state that the entrepreneurs are mainly better educated than the average, the majority has at least a maturation certification, while the proportion of those with vocational education as the highest qualification is still high. This latter fact may be explained by the boom in the services sector in Héviz and around the lake Balaton, which increases the demand for the entrepreneurs trained for services vocations. (Note that the proportion of entrepreneurs with vocational training as highest school qualification had risen in the former surveys as well, from 26 % in 1988 to 30 % in 1993.)
These figures seem to support the "theory" of the emergence of the middle class, and it is especially true taking into account that the density of small and medium size entreprises is higher around the Western shore of lake Balaton (17 enterprises per one km^2, or 44 enterprises per 1000 inhabitants in 1997) than the national average (11 enterprises per one km^2, or 33 enterprises per 1000 inhabitants in 1997*) (Csite, 2000).*

3.5 The age structure of the entrepreneurs

With the increasing number of the enterprises the proportion of younger entrepreneurs has also increased. In 1988 the proportion of entrepreneurs under the age of 30 was 7 %, it grew to 17 % in 1993, while our survey shows 20 % for Zala and Héviz, and 27 % for Keszthely.

In Keszthely the proportion of entrepreneurs with higher school qualifications, and the proportion of young entrepreneurs is higher than average. (The cohorts effect must be mentioned among the reasons, that is, the proportion of people with higher school qualifications is higher among the younger than among the older population.) However, the proportion of entrepreneurs above the age of 50 is also quite high (24%).It was surprising to see that in Keszthely the proportion of entrepreneurs between 31 and 40 is very low (20%), while in Héviz this age group represents the highest proportion (50%). In Somogy, where the total population is getting older, the proportion of the older entrepreneurs is also higher (24 % of the entrepreneurs is above 50) (see figure 4).

Among the part time entrepreneurs the proportion of those older than 50 is high - 51 % in Zala, 50 % in the Balaton settlements, 39 % in Somogy, 20 % in Héviz and 31 % in Keszthely. This differs from the results of the 1988 and 1993 surveys, where the authors found the part time entrepreneurs to be younger than the full time entrepreneurs (see figure 5). Our survey shows similar proportions in the

numbers of the full time and the part time entrepreneurs to the two former surveys. The 1988 and 1993 surveys found the number of full time entrepreneurs being twice as much as the part time entrepreneurs, while in our survey 203 full time entrepreneurs and 84 part time entrepreneurs were found among the respondents.

Figure 4: The age structure of the full time entrepreneurs

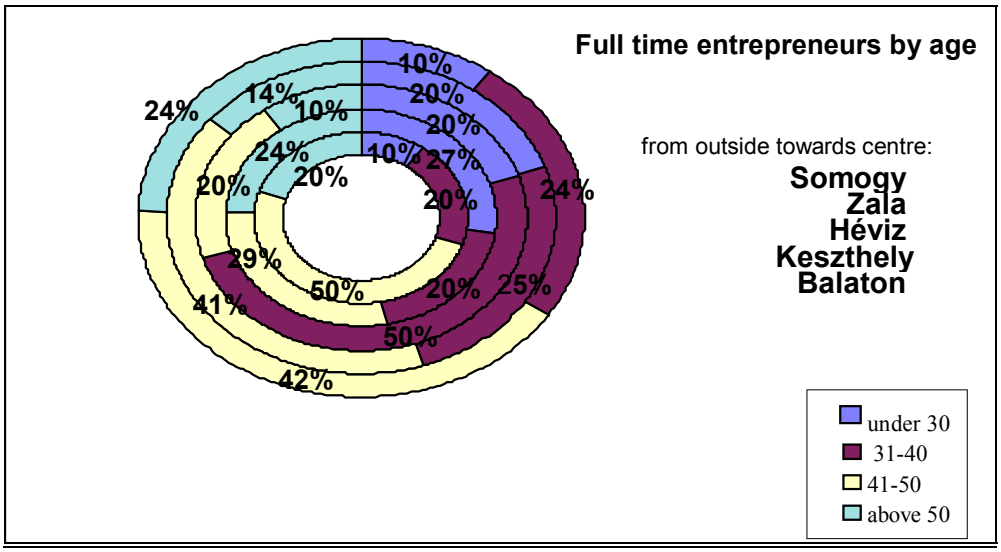
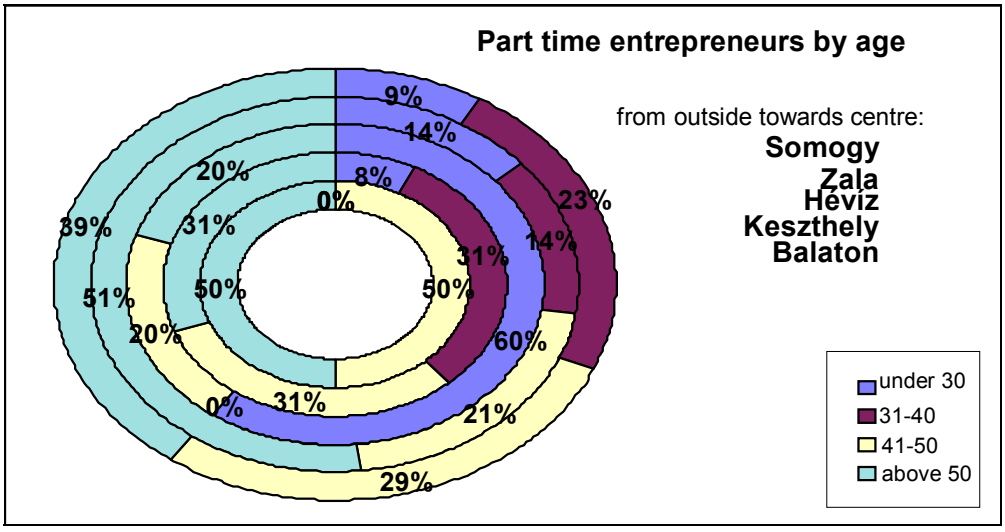


Figure 5: The age structure of the part time entrepreneurs



4. SUMMARY AND CONCLUSIONS

The group of small and medium size enterprises show a rather mixed picture. The entrepreneurs differ in several social and demographic traits. Not only the area of activity, the legal form of the enterprise are different, but the social and economic characteristics, too. The profitability and the respectability of the enterprises in the society also differ widely. In our research the largest differences were found between the mainly agricultural enterprises of Somogy and the small businesses of the two towns Keszthely and Héviz. Not only the school qualifications of the entrepreneurs differ but hte whole history of the enterprises and their opportunities for growth and development, too.

In the present survey several questions were researched. The first issue of interest was the reason for the fast increase in the number of the small and medium size enterprises. This increase may be the overall result of several factors. The first contributing factor is the loss of the employment possibilities provided by the state, the growing uncertainty about jobs. This process has probably increased the number of partnerships as well as the number of the sole proprietorships. On the other hand, formerly employed vocationally trained workers, having solid professional experience, sufficient financial resources ,marketable knowledge and skills, ready to make initiatives and take risks, decided to establish their own businesses and became private entrepreneurs. The second reason may be the desire to achieve tax reduction and income maximisation which are legally possible within an enterprise. The third contributing factor is the desire to maintain or increase the former living standard, as an enterprise offers wider opportunities for higher or additional incomes, or often it is the only available income source, as it is true for the "forced" enterprises.

The second issue of interest was the social stratification of the rather heterogeneous group of entrepreneurs, and whether any changes are identifiable during the last 10 years. Basically the typical entrepreneur is the same as in 1988, that is, middle age well educated man. However, there is a strong tendency towards younger age groups, and the proportion of women and university graduates has also been growing. This indicates a change which may be continued in the next years. The results point out a slight trend of growth and expansion. The enterprises capable of providing sufficient income for the entrepreneur for a decent standard of living are those, which turn back part of their gains into the business itself. The majority of the private entrepreneurs using up their business savings in the household - for consumer goods or home investments - cannot rely entirely on the entreprise as the only income source. Considering the resulting living standard the entrepreneurs separating their business and household finances seem to reach the best results.

It is not clear whether the profitability or unprofitability of the business indicates the success of failure of the enterprise itself. It is far from being certain the the enterprise being profitable according to its accounts is really successful and sound. The enterprises operating only at breakeven point, or even below it may grow faster, operate more efficiently, accumulate capital, create jobs, expand their market and activity profile - in spite of the heavy losses shown in their accounts. The explanation is that these businesses do not have to pay tax after their gains, while the average profitable businesses do. The problems and difficulties may be listed long. Researchers may find additional difficulties in the terminology used, as many of the used expressions have lost or changed their traditional meaning and this means further challenges for future research.

REFERENCES:

1. CZAKÓ Á. (1997);Kisvállalkozások a kilencvenes évek elején. *(Small businesses at the early nineties).*Szociológiai Szemle, 3. 93-106.
2. CZAKÓ Á.,KUCZI T.,LENGYEL GY.,VAJDA Á. (1995): A kisvállalkozások néhány jellemzője a kilencvenes évek elején.*(Some characteristics of small enterprises at the beginning of the nineties).* Közgazdasági Szemle, 42. 4. 399-419.
3. CSITE A. (2000): Turizmus és politika: A kispolgárság felemelkedése a Nyugat-Balatonnál. Kézirat. (*Tourism and politics: the prosperity of the middle class at West-Balaton. Unpublished manuscript.)*
4. GÁBOR R. ISTVÁN (1994): Kisvállalkozás Magyarországon - virul vagy satnyul? *(Small enterprises in Hungary - prosperity or withering?)* Közgazdasági Szemle, 7-8. sz.
5. KOVÁCH I. (1995): Polgárosodás: új burzsoázia vagy a gazdasági elit szerepvállalása? (*Emergence of the middle class: new bourgoisie or the growing role of the economic elite?)* In: Róbert. P. et al. (szerk.) Középosztályok nyomában. Budapest, MTA PTI, 99-116.
6. KOVÁCH I. (1997): Polgárosodás vidéken (kézirat) *(Emergence of the middle class in the countryside. Unpublished manuscript).*
7. MATOLCSY GY. , DICZHÁZI B. (1998): A növekedés regionális forrásai. *(The sources of growth)* Társadalmi Szemle, 1. 21-36.
8. SZELÉNYI I. (1990): Új osztály, állam, politika. *(New class, state, politics).* Európa Könyvkiadó, Budapest.